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The Welding Engineer

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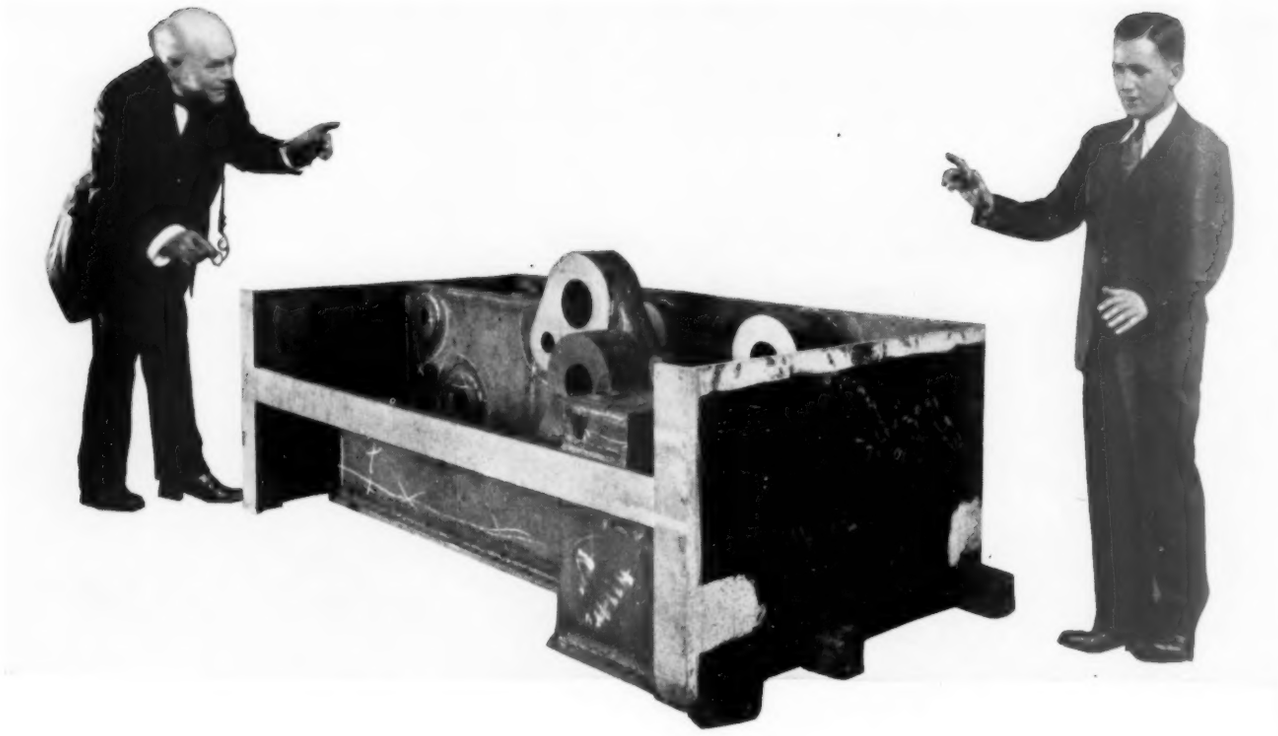

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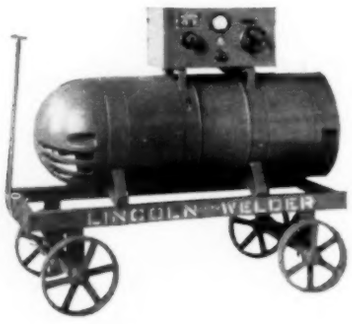

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· E D I T O R I A L ·

MACHINERY AND EMPLOYMENT

• In the year 1837 there were no automatic screw machines, no typewriters, no steam turbines, no forty-story buildings, no merchant bar mills, no 70-mile per hour carriers, no cigarette lighters. Work was done by muscle. Since labor-displacing machinery was very rare, twelve and fourteen hours was not unusual for a day's toil. Yet in the year 1837 the people had their worries the same as we have ours in this machine age. Witness the fact that in this year a severe panic caused every bank in the United States to close, and a number of the states repudiated their public debts. ¶ On exhibit in a building at "A Century of Progress" is an automobile of the year 1901. This car sold for $665 new. In the same building are shown the latest automobile models, which so far outstrip the 1901 car in appearance, speed and comfort that comparison is odious, and yet some of these finest cars can be bought for a price no greater than the sale price of the 1901 car. The 1901 vehicle represented the acme of human skill of that time, with hand-shaped spokes in its wheels, hand-drilled and hand-finished engine parts and accessories, with body and mud guards composed of sheets cut and finished by hand, piece by piece. Now it stands alone as a relic, attracting the eye of the curious in the passing throngs, while all the buyers are clustered around the new models. ¶ How is it that this early car, designed and built by skilled craftsmen, has been replaced by a car with conveniences and comforts undreamed of thirty years ago and which sells for no higher price? The explanation becomes quite obvious when one views the assembly floor in this same building. Here a flash welder makes 100 inches of welds on side and rear panels in just 35 seconds. Spray guns coat the body quickly with a glossy substance that is little affected by dirt and grime and dust. Motor-driven drills and screw drivers speed up the assembly operations. It is a fitting demonstration of how man's ingenuity has developed labor-saving machines and equipment which permit lower production costs and which result in a better product for the same price, and this in turn creates a greater demand and further decreases the unit cost of production. ¶ Despite the lack of automatic machinery in 1901, the number of men engaged in the production of cars was but a small fraction of the total number employed in like pursuits today. The answer is that the flash welder, the mechanical conveyor, the multiple spindle drill, when applied to the automobile, put far more men to work in that industry than they ever laid off. In an indirect way, many others have been employed through the resourcefulness of this industry in adopting labor-saving and cost-cutting methods, for during the past five years it set many to work in the cement mills and quarries all over the country and in the mixing of these ingredients and the flowing of them in strips over the surface of this country to form our net work of hard roads. It has created new demands for steel for ore carriers on the Great Lakes, for blast and open-hearth furnaces and for sheet mills. ¶ The growth of the automobile industry is an excellent demonstration of the fact that equipment which will reduce costs will at the same time increase wealth and put into the hands of the average family means for attaining luxuries which heretofore were denied them. That is why the industry has prospered and caused many other industries to prosper with it. It has increased employment (if we disregard the past three years of economic upheaval which was aggravated by the wholesale hoarding of wealth), has added incalculable wealth to the resources of this country, has increased our standard of living through a distribution of this wealth, and has reduced the hours of man's labor so he is better able to enjoy the increased wealth which is his heritage. ¶ The rise of the automobile industry teaches the lesson that any scheme for the increasing of employment and of the standard of living must rest on the basis of an increased spread between lower costs and higher wages, which can be obtained only through the further use of machinery and processes that will lower costs and increase output through the stimulation of increased demand for the lower-priced product. That is the key to increased employment, although in applying it one must recognize the fact that it all goes for naught if the wealth produced by labor-saving machinery and processes is not invested or exchanged for goods but is hoarded. Let us face the plain fact that this nation of 50 million able-bodied workers can produce 120,000 million man-hours of wealth a year without the aid of machines, by working 60 hours a week; but the cotton gin, the gantry crane, the rotary web press, the oil-well pump, the kitchen gas range, and other labor-saving devices make it possible to increase this wealth to 200,000 man-hours with an actual expenditure of only, say, 90 man-hours. Hence, though his working hours are fewer, man is enabled to enjoy more of the conveniences and luxuries of the machine age. ¶ Because the industrial stagnation of 1932 and early 1933 coincided with a high development in the scientific application of engineering principles to the use of materials, machines, and processes designed to produce better products at lower costs, it does not follow that the machine age was the fault of the debacle. ¶ Though the cynics sneer, the fact is incontrovertible that wealth is created only by work, whether done by muscle or machine. Wherever the machine is more efficient than muscle, in it lies the hope for reducing costs and for an orderly increase in employment and trade.

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The Welding Engineer

VOLUME 18 SEPTEMBER, 1933 NUMBER 9

Welds and Stresses . . .

By H. N. BOETCHER
Consolidated Gas Electric Light and Power Co., Baltimore

A critical study of stresses in welds and welded structures and of the effect of weld design and welding technique on stresses

THE technical and economic success of a welding job as well as of any engineering project depends on a reasonable balance between the stresses to which it is subjected and the properties which it has. If these two factors are not properly correlated, the result is either a technical failure or excessive cost. Inasmuch as every individual welding job involves different problems, it is necessary to have an understanding of the fundamental relationship between the stresses and the properties of welded joints. The following discussion is intended to present a number of points which may be helpful even if they do not cover every detail by any means.

First of all, it is necessary to refer to the frequently disregarded fundamental fact that the properties of the fused-in metal are only one of many factors determining the properties of a welded joint. Others are features of design, shape and size of reinforcements, penetration and soundness, structural and physical changes in the steel adjacent to the weld, and stress conditions. The responsibility of the welding engineer is not confined to the production of good welding metal, but covers the production of good welded joints to suit the structure which they serve.

As long as welds were used merely to replace riveting, bolting, or other methods of joining metals, it was sufficient that the strength of the welded joint

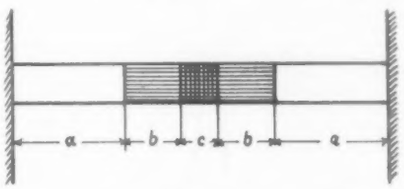


Fig. 1. Illustrating Zones of Different Heat in Piece of Steel.

should be as high as that of a corresponding joint made by the method replaced. While this condition constitutes only a limited progress in engineering, the use of welding in the design of structures and the substitution of welded rolled steel for castings have led the engineering world to expect a welded structure to have the same strength and properties as if it were made of uniform steel throughout, without any joints. Since the attainment of this goal is possible to a certain extent with welding, stresses should be considered from this point of view.

Roughly speaking, three types of stresses occur. Internal stresses are caused by temperature conditions during and after welding. Static external stresses are imposed by loads tending to stress, compress, bend, or shear the welded joint—loads which may be the result of temperature conditions as well as of dead weight. If the loads are of a recurring or reversing type, the joint will be subjected to stresses tending to cause fatigue failures, which are much more frequent than it is generally assumed.

Solving the Problem of High Internal Stresses

A great deal of trouble experienced with cracking of welded joints as a result of excessive inner stresses could be avoided by a common-sense application

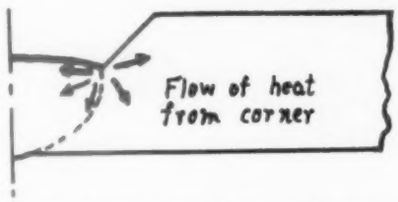


Fig. 3. Cooling Conditions at Corner at Beginning of Second Layer of Two-Layer Electric-Arc Weld.

of well-known physical facts. It may not be amiss, therefore, to give an account of these facts and to indicate their application to various conditions of welds. Inner stresses appear in any engineering material subjected to cold working or thermal treatment. Though many problems in castings have some similarity to those of welding, a particular condition arises from the fact that

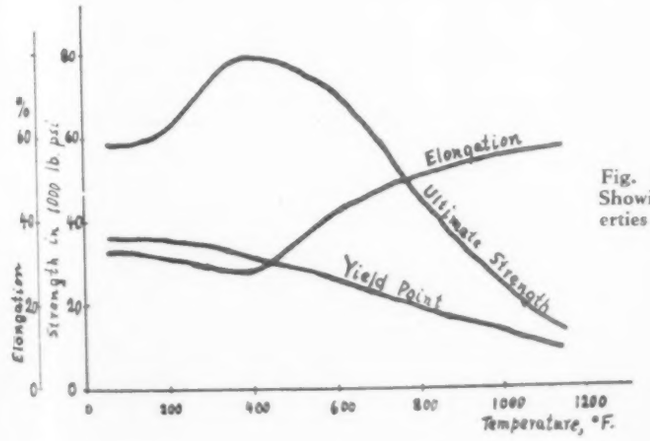


Fig. 2. Typical Curves Showing Change in Properties of Steel With Temperature.

welding involves a relatively small "casting" which firmly adheres to a chilling metallic "mold".

The simplest form of this type of process is represented by Fig. 1, showing a uniform piece of metal. Both ends of the specimen are fixed. Zone *c* is supposed to have been heated to melting temperature. The temperature of zones *b*, *b* decreases from melting temperature to the temperature of the "cold" zones *a*, *a*. The heat of *c* and *b* is dissipated both by radiation and by flow of heat into *a*. Accordingly, while *b* and *c* combine after solidification of *c*, the hot zone progresses into *a* until radiation or other methods of cooling are sufficient to take off the heat. During this time, the contraction of the cooling metal is partly balanced by the expansion of the metal heated by the flow of heat from *c* into *b* into *a*, with a gradually growing excess of contraction.

Fig. 2 gives an indication of what to expect in the metal. Quite apparently, at very high temperatures, all changes in length will be taken up by plastic deformation of the hottest metal. This condition changes with cooling since, for instance, at 1100°F., the metal must be subjected to a stress of about 12,000 lb. per sq. in. before any plastic deformation can take place in the hot metal. Accordingly, the contraction is taken up by elastic stretching of the entire section between fixed points until the lowest yield point of any metal within the section is reached. With a lowering of maximum temperatures, a greater percentage, if not all, of the contraction can be balanced by elastic deformation. Evidently, the greater the ratio of total length to heated zone, or, in other words, of total effective length to heat input, the lower the stresses will be.

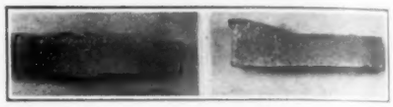
If the conditions of Figs. 1 and 2 are applied to welds, it would seem that the contraction stresses, on this basis, are lowest with quick-working methods, such as electric-arc and certain recent oxyacetylene processes. In practical use, however, complications result from changing effective cross-sections and from differences in local metal characteristics which often reverse this general statement, especially in reference to localized conditions.

If the cross-section of the weld varies from the effective cross-section of the base metal, the unit stresses, of course, differ according to the ratio of the cross-sections. Accordingly, if the weld is much thicker than the base steel, the stresses may be such that the yield point of the cooler base metal will be exceeded without plastic stretching of the weld metal, especially at low weld temperatures after considerable cooling. This condition is still more severe in the longitudinal direction of the weld, on account of the greater amount of total contraction, and explains the cracks not infrequently found in the steel next to a heavy weld of thin material when all or nearly all of the contraction at lower temperatures has to be taken up by the base metal.

Cracks in Welds Produced by Localized Stresses

The reverse case of a weld cross-section smaller than the effective cross-section of the base steel is much more frequent than it might be thought. Such cases include, in addition to the obvious ones, welds having incipient cracks, which often result from localized stresses, these cracks leading later to general failures. These stresses are the result of the quick cooling of a small amount of metal within a comparatively large mass of cooler base metal and previously flowed-in weld metal—a condition most pronounced when the total heat input is low, as in electric-arc and quick-working oxyacetylene welding processes. Since the metal at very close distance to the momentary welding point already has a high yield point, on account of the rapid temperature drop, the effective cross-section of the metal to which contraction might be transmitted is large compared with the hot metal and forces practically all of the stretching into the flowed-in metal, thereby involving the possibility of high residual stresses or even cracks. Cracking would not necessarily occur in the weld metal, but may take place in the immediately adjacent steel which is similarly heated, especially if this steel is exposed to unduly severe chilling action. Figs. 3 and 4 relate to a case in which the cracks appeared in the corner indicated in Fig. 3. The cracking, in this case, occurred at a point at which the conditions referred to were especially pronounced.

It remains to be mentioned that certain conditions may multiply the natural rate of contraction at localized spots



Electric-Arc Weld (Fig. 5, left) and Oxyacetylene Weld (Fig. 6, right), Indicating Relative Uniformity of Heat Flow Along V-Bevel by Structural Changes.

—conditions which may play a greater part than we know at present. One such case was pointed out by H. S. George[1] for welds started from an edge. The relatively lower heat transfer to air keeps the metal at the edge hotter than the metal next to it which is cooled by heat flow into metal. With the contraction of the seam by the continued welding, the cooler metal operates as the pivot of a lever tending to stretch the metal at the edge and, thereby, sometimes causing incipient cracks at this point.

Means for Distributing Local Locked-Up Stresses

An understanding of contraction stress conditions gives a key to the mechanism and necessity of annealing heat-treatment. Referring to Fig. 2, we realize that the heating of steel containing locally concentrated locked-up stresses to a temperature at which the yield point is very low must necessarily serve to distribute all stresses in excess of this yield point uniformly over the metal. Practically uniform cooling from this temperature, though it does not remove the inner stresses, results in a uniform distribution which usually produces a negligible unit stress. Heating to about 1100° to 1300°F. is generally sufficient for satisfactorily uniform stress distribution. Heating above the temperature of recrystallization would be more desirable, since it removes structural differences within any one metal as well as stress differences, but it is not always possible since the step in the time-temperature

Fig. 4. Photomicrograph (400 diameters) Showing Crack at Corner Indicated in Fig 3.

(1) "The Cause and Prevention of Heat Cracks in Aircraft Welding," by H. S. George, *Mechanical Engineering*, Vol. 53, No. 6.

curve is liable to cause warping at the critical point due to temperature differences within the structure.

As far as the necessity of stress-relieving is concerned, "general" stresses (cross-sections being approximately equivalent) are rarely large enough to demand relief, since the flow of heat serves to distribute these stresses during welding. This condition is demonstrated by the comparatively small warping of plates free to move when they are joined by a simple V-weld. This warping is much less than it would be expected from the difference in width of the weld at surface and root. Conditions of heat radiation and heat flow serve to effect a comparatively uniform temperature distribution so that the weld behaves almost as if it had parallel walls. The structural changes in the steel in Figs. 5 and 6 illustrate this condition by indicating the limits to which the metal has been heated to about 1500° F. Since the weld in Fig. 6 was made in two layers, only the first layer should be considered in this respect.

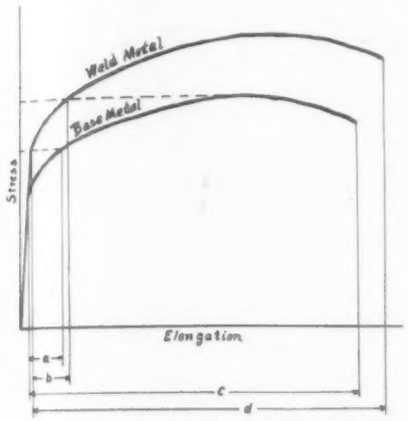


Fig. 7. Effect of Differences in Strength and Ductility Between Weld and Base Metal (diagrammatic).

Very short distances between fixed points at both sides of the weld, and long uninterrupted welds, may necessitate stress-relief also for "general" stresses. Conditions are different in regard to localized stresses which may be quite high—a fact which indicates the desirability of stress-relieving especially welds made by the electric-arc or accelerated methods of oxyacetylene welding.

In this connection, peening should be mentioned as a mechanical method of relieving stresses by restoring approximate original spacings by stretching the weld metal. Since the working of the metal destroys a good deal of its ductility, this method is preferably used with layers of electric-arc welds which are reheated afterwards above the point of recrystallization by the welding-on of additional layers. The working improves the physical properties of the metal if it is followed by recrystallization.

Consideration of Static External Stresses

The requirement, mentioned above, that welded structures should behave as if they were made of uniform metal throughout adds the problem of flexibility to that of strength. The welded joint should not only be as strong as the original steel, but also as flexible. While ductility of the weld metal, in itself, is of importance for the distribution of inner stresses, it is, in relation to external stresses, only one factor which is coordinated with yield point, weld cross-section, and shape of the weld. This condition is illustrated in Fig. 7 by assuming a weld metal of higher strength and ductility than the base steel, with cross-sections equal. Weld reinforcements have a similar effect, with equal strength of weld and base metal, and accentuate it if the weld metal is stronger than the base steel. The modulus of elasticity is assumed to be identical. Evidently, the base steel is subject to a permanent deformation *a* before the weld metal even reaches the limit of its elasticity. The maximum useful elongation *b* of the weld metal is only a fraction of its maximum possible ductility *d* and of the ductility *c* of the base steel. The result of this condition is shown by Fig. 8.

The ideal condition, apparently, would be a yield point of the weld as such equal to that of the base structure, a condition which would require a lower yield point in pounds per square inch of the weld metal than of the base steel, considering the customary weld reinforcement. This fact demonstrates the futility of the boast of many a salesman of a "weld metal stronger than the steel." An intelligent interpretation of the functions of welds within steel structures will disclose, however, that flexibility of the welded joints is not always necessary and that strength alone is frequently sufficient.

Still, in more cases than it is usually realized, lack of flexibility superimposes bending, shearing, or other conditions on the service stresses, especially in the steel close to the weld. A condition of this type is, for example, shown in Figs. 9 and 10, which illustrate welded pipe sections that have been subjected to destructive hydrostatic pressure tests and are representative of several similar tests. The high strength of the weld metal as shown in Fig. 9 caused bending stresses in the steel next to it by inhibiting expansion. Though the weld metal in this instance had a tensile strength 9% higher than that of the pipe shown in Fig. 10, the bursting pressure was 5% lower and the crack continued through and beyond the weld, while the relatively uniform expansion of the specimen shown in Fig. 10 avoided excessive stress concentrations at or near the weld and permitted a quick release of the locked-in energy as soon as the lap weld of the pipe opened up.

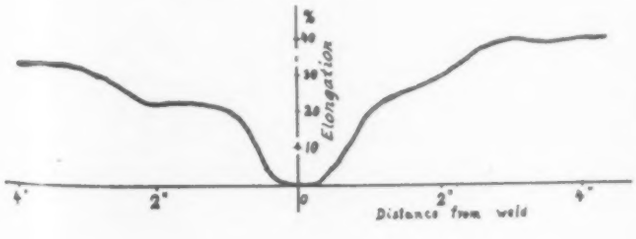


Fig. 8. Rigidity of Weld of High Strength as shown by Elongation.

Most Service Failures Caused by "Fatigue"

It is probably a safe statement to make that by far most failures of metallic materials experienced in actual service can be charged to "fatigue". Another safe statement is that the results of fatigue research work are frequently applied—if at all—only after costly failures have demonstrated the folly of neglecting them. This is true also with welding—a field in which the additional difficulty is encountered that failures caused by fatigue may be and have been erroneously charged to inner stresses, in at least a number of cases, the reason being that most engineers still have a rather vague knowledge of fatigue conditions. Since this paper is written for the practical welding engineer rather than the research man, it may be well to restate some major factors determining "fatigue" without going into the theory of the matter.

Figs. 9 (left) and 10 (right). Effect of Weld Strength as Shown by Results of Hydrostatic Test.

If a material is loaded repeatedly above a certain stress, small microscopic cracks develop after a number of repetitions or reversals and finally cause fail-

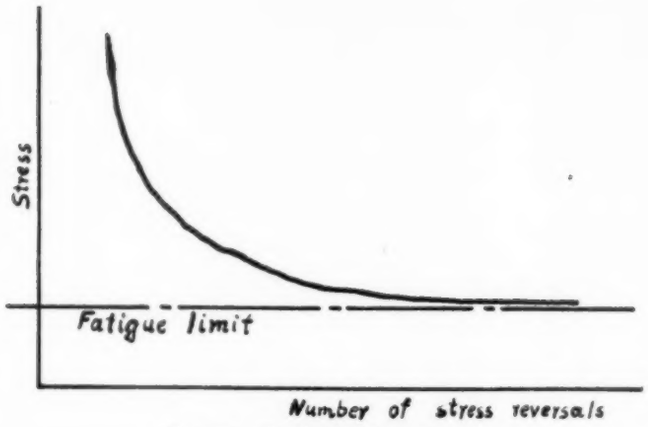


Fig. 11. Typical Fatigue Curve.

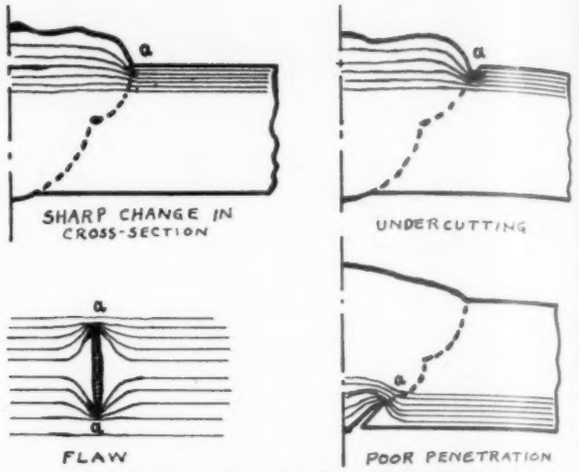


Fig. 12. Stress Concentrations Resulting From Welding Defects.

ure of the piece. If the number of reversals needed for a fracture is determined for various stresses, a curve similar to Fig. 11 results. Evidently, any material subject to vibration or stress reversals in service should be stressed safely below the "fatigue limit". The fatigue limit, however, is not a fixed property, but depends on the type of load application, on fixed base loads, and other factors.

The fatigue limit of any metal for certain conditions can be determined by tests. In practical application, however, a large number of factors exist which tend to lower the fatigue strength. One is corrosion, which is so important that "corrosion fatigue" has been treated as a separate factor by investigators; the corrosion fatigue limit may be but a fraction of the fatigue limit, depending on the type of metal.

It was shown above that the physical properties of weld metal have only a relative importance in relation to the strength of the welded joint. This is still more true in reference to the "fatigue limit", the reason being that stresses causing fatigue failures are generally lower than the yield point of the metal and, therefore, do not permit of relief by deformation when localized stress concentrations are present.

Conditions Producing Localized Stress Concentrations

Such stress concentrations are obtained at any place at which lines of equal stress change their direction. A few diagrammatic cases are shown in Fig. 12. At points of stress concentration, the local stress exceeds the fatigue limit long before the average stress in the metal reaches this limit. Such points are marked *a* in the sketches. Cracks resulting from this condition cause increased stress concentration at the ends of the cracks and thus accelerate progress of the failure. No detailed discussion is needed to show that the sketches indicate the importance of soundness and good penetration and of a gradual increase in thickness of the reinforcement from the edge to the center of the weld without undercutting. Any sharp corners or excessive differences in thickness decrease the resistance of the welded joint against fatigue failure.

Since elastic deformation plays a part in fatigue and since tests have indicated that the modulus of elasticity may differ with different types of weld metal, it is quite possible, though not yet definitely proved, that higher strength of the weld metal, as compared with the parent steel, is another factor tending to cause stress concentration in the steel next to the weld and, therefore, to lower the fatigue resistance.

Fatigue tests of welded structures in service size and under service conditions are sometimes quite expensive. As a result, few such tests have been made and still fewer published. In view of the great practical value of tests of this type, it would be desirable if organizations and companies interested in welding would devote more attention to them. There is a large field yet to be covered in exploring the fatigue conditions in welded piping under pressure and temperature conditions including stresses caused by longitudinal expansion and contraction and by temperature gradients, in welded steel structures subjected to changing loads, etc. The value of such experiments is demonstrated, for instance, by tests recently made in Germany in reference to railroad bridges[2]; these investigations have given valuable points in regard to the design of welded structural joints for higher fatigue resistance. The simple determination of the fatigue limit of standard specimens of weld metal which so far is the usual "fatigue test" has a very limited value in view of the many other factors of importance which cause concentration of stresses, with the resulting decrease in average fatigue strength.

[2] "Dauerfestigkeit von Schweissverbindungen bei verschiedener Formgebung", by A. Thum and W. Schick, *VDI*, Vol. 77, No. 10. "Die Dauerfestigkeit der Schweissverbindungen", by G. Schaper, *VDI*, Vol. 77, No. 21.

Uncle Sam Wants Engineers

The United States Civil Service Commission announces open competitive examinations for Senior Engineers, Engineers, Associate Engineers, and Assistant Engineers. Applications must be on file with the U. S. Civil Service Commission at Washington, D. C., not later than September 28, 1933. The examinations are to fill vacancies occurring in the Federal classified service throughout the United States. The entrance salaries range from $2,600 to $5,400 a year, less a deduction of not to exceed 15% as a measure of economy and a retirement deduction of 3½%.

Optional branches are aeronautical, agricultural, civil, construction, electrical, heating and ventilating, highway, mechanical, mining, radio, structural, and telephone engineering.

Competitors will not be required to report for a written examination, but will be rated on their education and experience. Applicants must have had certain specified education and experience in engineering. Full information may be obtained from the Secretary of the United States Civil Service Board of Examiners at the post-office or customhouse in any city, or from the United States Civil Service Commission, Washington, D. C.

Welding Institute Formed in South Africa

The South African Welding Institute was recently established in Johannesburg, South Africa, and branches have been opened in Cape Town, East London, Uitenhage, and Durban. The purposes of this new technical body are to coordinate research, organize instruction, maintain control over the profession, and issue certificates of competency. The Institute expects to open regular schools of instruction in the large centers, who will issue certificates in three grades.

Program of Fall Meeting of American Welding Society

To Be Held in Book-Cadillac Hotel, Detroit, Mich., October 2nd to 5th

Monday, October 2nd

Morning

Registration facilities will be provided throughout the week from 9:30 a.m. to 5:00 p.m.

Afternoon

1:45 p.m. Opening Session. Presiding officer—M. P. Bailey, Chairman, Detroit Section.

Address of Welcome by the Mayor of Detroit, and response.

2:15 p.m. Technical Session. Presiding officer—F. P. McKibben, President.

"Gas Cutting of Structural Steel."

"Use of Shielded Carbon Arc in Class I Welding," by E. W. P. Smith, Consulting Engineer, The Lincoln Electric Co.

"Impact Values of Weld Metal," by J. C. Hodge, The Babcock & Wilcox Co.

"Building Up Pistons With Bronze," by T. W. Greene, Linde Air Products Co.

Evening

6:30 p.m. Dinner meeting, Board of Directors, Book-Cadillac Hotel.

Tuesday, October 3rd

Morning

9:45 a.m. Technical Session. Presiding officer—J. J. Crowe, Senior Vice-President.

"Manufacture of Small Everdur Tanks by Welding," by Ira T. Hook, American Brass Co.

"Welding of Non-Ferrous Piping," by D. E. Roberts, Linde Air Products Co.

"Welding of Non-Ferrous Metals and Alloy Steel," by representative from Thomson-Gibb Co.

"Physical Properties of Welded Cast Steel," by Chas. H. Jennings, Westinghouse Electric & Mfg. Co.

"Welding of Inconel," by J. G. Schoener and F. G. Flocke, The International Nickel Co., Inc.

Afternoon

2:00 p.m. Session on Fundamental Research in Welding. Presiding officer—C. A. Adams, Director, American Bureau of Welding.

"Tensile Tests of Welded and Riveted Structural Members," by R. P. Davis and G. P. Boomsliter, West Virginia University.

"Electric Arc Welding Under Water," by N. S. Hibshman, W. E. Harvey and C. D. Jensen, Lehigh University.

"The Effects of Motor Reactions in Electric Welding," by W. R. Woolrich and J. Tarboux, University of Tennessee, and C. T. Raymo and W. B. Parker.

"Fatigue of Metals," by G. E. Thornton, State College of Washington.

"Internal Stresses in Welds," by C. T. Schwarze, New York University.

"Magnetic Characteristics of Deposited Metal," by Wendell F. Hess, Rensselaer Polytechnic Institute.

"Stress Distribution on Welded Connections," by S. C. Hollister, Purdue University.

Evening

7:30 p.m. Conference and meeting of Fundamental Research Committee, American Bureau of Welding, H. M. Hobart, Chairman, presiding. Book-Cadillac Hotel.

8:00 p.m. "The Prosperity Process," a 4-act drama. Masonic Temple.

Wednesday, October 4th

Morning

9:45 a.m. Resistance Welding Session. Presiding officer—R. E. Powell, Western Electric Co.

"Automatic Controls for Electric Welding," by H. W. Roth, President, Controloweld, Inc.

"Controlled Welding," by O. C. Frederick, General Electric Co.

"Precision Spot Welding With Tube-Controlled Contactors," by C. Stansbury, Cutler-Hammer, Inc.

"Timing of Spot Welders With Reference to Current Flow," by D. C. Wright, Chief Engineer, The Electric Controller & Mfg. Co.

Afternoon

Inspection trip, leaving Book-Cadillac Hotel at 1:15 p.m. Arranged by the Detroit Section, this trip will include visits to the welding departments of the Kelsey Hayes Wheel Corp., the Ford Motor Co., and an automobile-body plant.

Thursday, October 5th

Morning

9:45 a.m. Technical Session. Presiding officer — A. S. Douglass, Chairman, Detroit Section Program Committee.

"Shipbuilding Welding," by G. H. Moore, Jr., Newport News Shipbuilding & Dry Dock Co.

"Welding of Structural Nickel Steel," by W. L. Warner, Watertown Arsenal.

"Welding of Galvanized Steel," by Leon C. Bibber, Bureau of Construction & Repair, Navy Department.

"An Aircraft Manufacturer's Experience With Welding Quality Control," by T. H. Speller and P. N. Jansen, Curtiss Aeroplane & Motor Co., Inc.

Afternoon

2:00 p.m. Technical Session. Presiding officer—M. P. Bailey, Chairman, Detroit Section.

"Shop Setup for Fabrication of Welded Machinery," by R. R. Kondal, Wickes Boiler Co.

"Modern Rail Welding Without Interrupting Traffic," by J. H. Deppeler, Metal & Thermit Corp.

"Pressure Regulators and Regulation Problems," by Geo. M. Deming, Air Reduction Sales Co.

"The Oxyacetylene Process in the Automotive Industries," by G. B. Purcell, G. B. Purcell Welding Shop.

"Welding as an Aid to Modernization of Breweries," by D. S. Lloyd, Dominion Oxygen Co. of Canada.

"Welding in the Automotive Industry," by C. A. Bowlus, Welding Sales & Engineering Co.

"Limitations of X-Ray Inspection," by Col. A. S. Douglass, The Detroit Edison Co.

Evening

7:00 p.m. Annual Banquet, followed by dancing. Book-Cadillac Hotel.

American Welding Society Issues New Pamphlets

Two new publications in pamphlet form have been issued by the American Welding Society, 33 West 39th St., New York, N. Y. Both deal with structural steel welding.

One is a reprint of a paper by Prof. Frank P. McKibben delivered before the last annual meeting of the Society, in which the growth of the adoption of welding in building codes is pointed out, methods for studying stresses in welded and riveted joints are outlined, useful information is given on structural details for welding and means for estimating welding costs for multi-story buildings, suggestions are offered for qualifying welders, and the strengthening of wrought-iron and steel bridges is discussed at length. This paper is available at 35c per copy.

The other publication is a comprehensive treatise on "The Practical Design of Welded Steel Structures," by H. M. Priest, designing engineer, American Bridge Co. This covers such subjects as inspection, the A.W.S. building code, stress distribution in fillet welds, and attachment of structural shapes and angles. Data are given on plate girders, column bases, trusses, splices, and beam connections. Several charts are included.

Welding Copper by the "Lon

A NEW procedure in the application of the electric arc to copper welding has been in course of development during the past year and has new reached the state of perfection where it is being successfully applied in a number of plants. The high speed, economy, total lack of warpage, and high strength of the weld metal without much reduction in the strength of the parent metal affected by the welding heat—these properties characterize this new method of copper welding by the arc, and account for the increasing use of this new process.

The new procedure requires the use of a specially developed filler rod, known as "Hobronz," and welding machines capable of delivering full amperage with a long, high-voltage carbon arc.

With this new technique, new rod, and high-capacity machines, it is now possible for the first time to arc-weld ordinary copper economically in the fabrication of tanks, barrels, vaults, kettles, and other copper products in which the extra strength of special copper alloys is not essential.

New Process Shows Large Savings in Cost

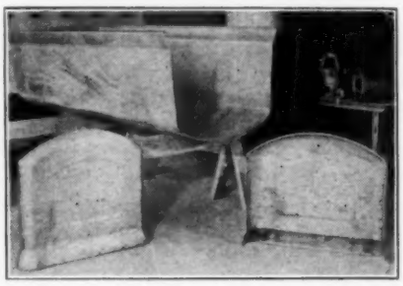
The important result is, of course, that it is now possible to use ordinary copper, with a great saving in cost, for many purposes where it had previously been necessary to use complicated methods that ran up the fabrication costs or use special alloys at prices substantially higher than prices of ordinary copper. With this new procedure, it can be stated definitely that no metal can be fabricated more rapidly or at a lower cost than copper.

Two men with vision are responsible for this development — Robert Bercaw, chief welding instructor for The Hobart Brothers Co., and W. C. Swift, service engineer for The American Brass Co. With the plant of the Hobart Brothers Co. at their disposal, they have for practically a full year conducted experiments and handled practical work with the idea of perfecting a method of satisfactorily and economically arc-welding ordinary copper. In the face of smiles on the part of engineers, research departments, and practical coppersmiths, they persevered until the time came when the result of their labors was acknoweldged as one of the outstanding developments in recent years in furthering the practical use of electric-arc welding.

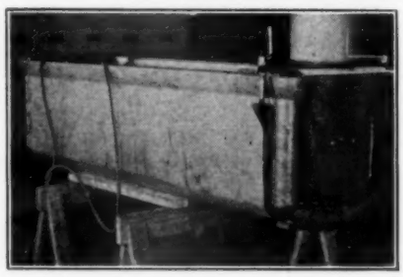
At one stage of their work, it is amusing to recall, a coppersmith of long experience and high standing in the trade actually required that he be guaranteed against possible spoilage of the copper utilized in welding some special tanks by the "Long-Arc" welding process, by which name the new technique is known. He stated that he had had previous experience with attempts to arc-weld ordinary copper and didn't propose to lose any more material. Research engineers would not, at that time, approve the arc-welding process for ordinary copper, so, in order to give Mr. Bercaw and Mr. Swift this opportunity to demonstrate the safety of the new Long-Arc method, The Hobart Brothers Co. had to guarantee him against any possible material loss. The job was done with a great saving in fabricating costs, submitted to tests, and that man is now one of the most enthusiastic boosters of the new Long-Arc welding process.

The first really practical production work, in connection with which the new welding process was used, was in arc-welding copper burial vaults. It has long been recognized that copper vaults will far outlive steel vaults, especialy in certain soils. The cost of fabricating copper, however, added to the extra cost of the metal itself, greatly restricted the market for copper vaults.

STEPS IN THE MANUFACTURE OF COPPER GRAVE VAULTS

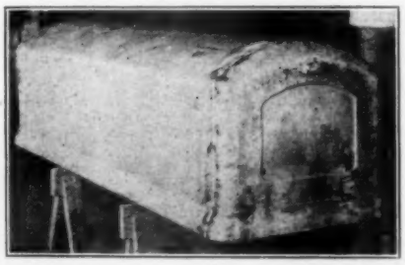


Three pieces of 12-gauge copper formed and ready for welding.



Pieces clamped in position to weld. The body overlaps the ends about ¾ in.

The seams are tack-welded on the inside, then the full weld completed inside, after which the double-lap weld is completed on the outside.



The completely welded vault requires no squaring up and shows no buckling or warping. It is now ready for grinding, testing, and final polishing.

No Distortion After Welding

The Springfield Metallic Casket Co., Springfield, Ohio, had been fabricating their copper vaults, with patented joints, by riveting and soldering. After the joints were finished, they had to electroplate the entire vault in order to cover the rivet heads and solder. Faced with a demand for copper vaults, they formed three vaults of 12-gage copper and had Mr. Bercaw weld them at the Hobart factory. They were much surprised to find no evidence of distortion after welding. In fact, they did not even have to use the special "squaring up" clamps used after welding steel vaults.

These three vaults were finished and tested in the Springfield plant, the test being made in water by the "diving bell" principle which, it is said, provides a pressure of 3,000 lb. for leak test. The results were so highly satisfactory that Mr. Bercaw was engaged to instruct their own operators, and they have since been arc-welding their own copper vaults of both 12-gage and 10-gage metal at an enormous saving in fabrication time and cost.

Each vault comprises a 7x7-ft. copper plate rolled into the shape of an open-end dome, 31 in. high and 30 in. wide at the bottom, with ends cut from copper sheet to fit perfectly into the open ends of the dome. There is 7½ ft. of welding at each end, making a total of 15 ft. It is customary to weld the seams inside as well as outside.

This type of vault is being welded by the Long-Arc process in 30 minutes. By the old process, it generally took several hours and then several days had to be spent in straightening out the welded

c" Method

By W. J. CHAFFEE
The Hobart Brothers Co.

This new carbon-arc technique is applicable to ordinary copper and is characterized by a high speed which minimizes distortion and other heat effects and greatly reduces fabrication costs.

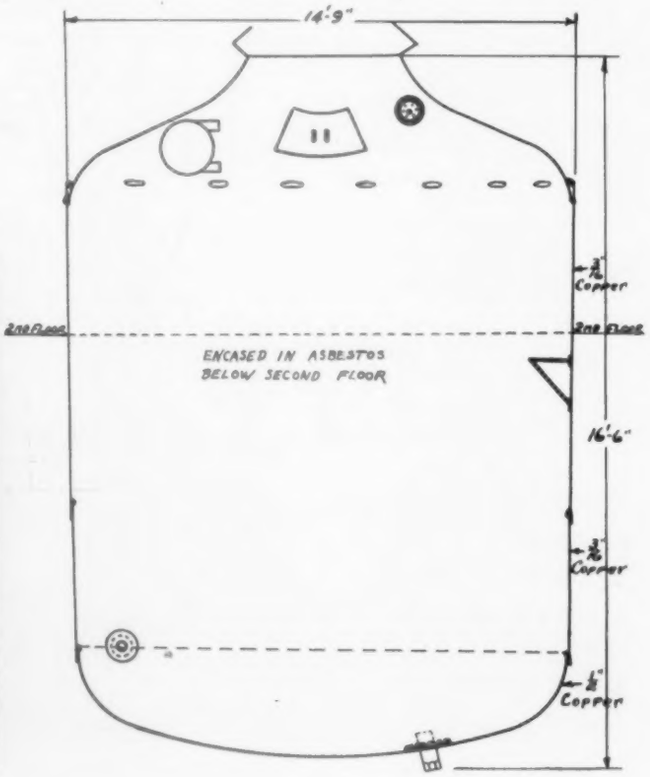
vault. After Long-Arc welding, the ends and sides of the vault are perfectly true, and it is not at all unusual for the welding heat to be undiscernible more than ½ in. from the weld. By the old process, the heat would burn the copper 12 to 24 in. away from the weld.

The largest job, however, and the one that has presented the most difficult problems to date, was the arc welding of a special copper brewing kettle at the Frank Fehr Brewery in Louisville, Ky. The accompanying photograph shows only that portion of the kettle appearing above the second floor as indicated in the sketch. The portion below the second floor was encased in asbestos packing so that no comprehensive photograph could be obtained. This job was contracted by Matt Corcoran & Co., well-known coppersmiths of Louisville, the original plan being to use the time-honored method of riveting and soldering the seams.

After seeing practical tests of the new Long-Arc method of welding, however, Mr. Corcoran arranged to have the Hobart Brothers Co. weld the kettle, and that company, in turn, turned the contract over to The Service Welding & Machine Co., of Louisville, whose chief operator had been instructed in the Long-Arc method of welding by Mr. Bercaw. Here are a few of the available statistics on this job:

The kettle has a capacity of approximately 500 barrels. It is 14 ft. 9 in. in diameter and stands 16 ft. 6 in. high. The bottom is formed of ½-in. Anaconda copper, arc-welded into the barrel, which is of 3/16-in. Anaconda copper. The top, of the same material, 3/16 in. thick, is also arc-welded into the barrel. Thus, the construction involved not only the welding of 3/16-in. copper to 3/16-in. copper in welding the barrel and welding in the top, but also the welding of 3/16-in. copper to ½-in. copper in welding in the bottom. For welding the lighter material together, a 12-kw. Hobart 40-volt arc welder provided the current, but in welding the lighter material to the heavier material it was found necessary to use a 16-kw. Hobart 40-volt machine to compensate for the more

Diagram of Kettle for the Frank Fehr Brewery in Louisville, and View of Kettle After Welding, Showing Only Portion Above the Second Floor. View Taken With Scaffolding in Place and Before Cleaning. Note Lap Welds and Fittings Welded to Kettle by the Long-Arc Method.

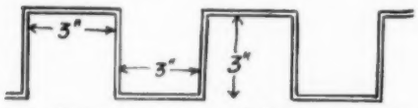


rapid dissipation of heat in the larger mass of copper.

The constructing of this kettle required approximately 15,000 lb. of Anaconda copper, 65 lb. of "Hobronz" welding rods of ¼-in. and 3/16-in. diameter, and 24 carbon sticks, ¼x12 in. Approximately 210 lineal ft. of seams was Long-Arc welded, and the job was completed in approximately 75 hours.

The shell was welded from 6 plates to form two rings having the same circumference as the kettle, one being 3 ft. high and the other 6 ft. Each ring comprised three 15-ft. 6-in. lengths of copper plate, making a total circumference of 46 ft. 6 in. The bottom, the two rings, and the top were fabricated in the plant of Matt Corcoran & Co. and then hauled to the brewery, where the seams were welded by the Long-Arc method. Because of the huge bulk of the material, all traffic had to stop as it was hauled through the streets of Louisville.

On arriving at the brewery, the pieces were hoisted into position and welded. The kettle was completed a week or two



The Dovetailed Seam, Joined by Spelter, Is Three Times as Long as the Straight Long-Arc-Welded Seam.

quicker than if the old process of riveting and soldering had been used. This saving in time was important for the Frank Fehr Brewery in view of the rush of orders for legalized beer requiring quick delivery.

The larger portion of the kettle, not shown in the picture, is packed in asbestos. Every step in the construction of this kettle was inspected and approved by a competent engineer on the job, and the vessel subjected to final tests which demonstrated without question the practicability of the new method. Substantial savings over the method originally contemplated also proved the economy of Long-Arc copper welding.

A Four-Day Job Done in Four Hours

Another example on record involved the construction of a "doubler," 8 ft. in diameter and 10 ft. high. The old method was to bevel or scarf all edges, generally by hammering. Then cuts are made in the proximate edges 3 or 4 in. apart and for a depth of 3 or 4 in. Alternate spaces or "tongues" between the cuts are bent down and up and the sheets are moved together so they lap this distance. The "tongues" are then fluxed and flowed with spelter consisting of 50% zinc and 50% copper in a molten state, after which the seam is thoroughly hammered. Such methods required from 4 days to a full week. Joints that cannot be made this way because the work must remain in a vertical position or for other cause, are riveted and soldered. By the Long-Arc method with "Hobronz," however, it was possible to arc-weld a straight seam, and the unit was completed in less than 4 hours.

These Pans Were Welded From Five Tons of 3/16-In. Copper Plate.

"Long-Arc" Welding on Large Copper Pans

The United Boiler Heating & Foundry Co., Hammond, Ind., have also had Mr. Bercaw instruct their operators in Long-Arc welding and have just finished fabricating three bottom pans for rotary mixers. These are constructed of Anaconda copper by this new method. The accompanying photographs show the character of this work. The original plan was to construct these vessels of steel, so the set-up was not ideal for the use of copper. Reports are that, even with the present set-up, the copper welding is as rapid as it would have been with steel. With a more favorable set-up for copper the welding time should be substantially reduced.

Approximately 5 tons of Anaconda copper and 120 lb. of "Hobronz" were required to complete the three vessels. These pans are semi-cylindrical. The semi-circular ends are Long-Arc welded into the rolled halves of the barrel. The fins, which also appear in the pictures, are likewise Long-Arc welded, these fins being of Anaconda copper. The angle-iron frame shown in the pictures is also arc welded.

Results of Tensile Tests

Early in May, 1933, when the burial vaults heretofore mentioned were welded, coupons of Long-Arc welded copper were tested for tensile strength. Even at that stage of the development, before the best analysis of rod had been finally developed, all the welded samples broke in the original metal, indicating a tensile strength of 23,000 to 25,000 lb. per sq. in. in the welded copper as against 30,000 to 33,000 lb. per sq. in. in the same metal before welding. This was considered as being exceptionally high strength for copper that had been subjected to welding heat—and the "Hobronz" welding rod has since been materially improved.

The "Hobronz" finally adopted as standard by Hobart Brothers was recently put through a very severe test in competition with all other types of copper and copper alloy rods. After instruction in the Long-Arc method by Mr. Bercaw, an operator of somewhat less experience welded some test pieces, which are now being tested by the manufacturers of Anaconda copper with a view to determining the results to be expected by operators others than Mr. Bercaw, who perfected the new welding technique. As soon as the results of these tests are ready, they will be available to all who are interested in fabricating copper.

Practical tests already completed at the Hobart Brothers factory indicate that Long-Arc welds with "Hobronz" on ordinary copper, using the technique developed by Mr. Bercaw, are very strong and ductile as compared with ordinary phosphor-bronze rods heretofore available. Really satisfactory results also require the use of a machine capable of

Unretouched View of Long-Arc Corner Weld on Copper Pan.

delivering the required high emperage at exceptionally high voltage across the arc. In some cases, for example, it has been found necessary to use an arc so long as to require 50 volts welding potential. Among the positive essentials of the new technique are a very long arc with plenty of heat, and rapid manipulation.

Speeds of 12 to 24 Inches per Minute

Rapid manipulation is necessary because "Hobronz" flows rapidly at comparatively low temperature, which makes it possible to move very rapidly along the seam with ample heat to accomplish the copper weld without applying excessive localized heat to the copper itself. Speeds of 12 to 24 in. per minute are possible, depending upon the thickness of the copper being welded. Thus, the copper is not burned or distorted as is the case where attempts are made to use the ordinary bronze and phosphor-bronze rods which require higher melting temperatures and more localized heat than "Hobronz" and consequently call for slower speeds with the arc playing on the copper for a greater length of time. "Hobronz," when properly manipulated, does not leave the copper with that reddish, "burned" appearance as is the case when ordinary copper or copper alloy rods are used. Welds with "Hobronz" also show far higher strength and ductility. In fact, "Hobronz" welds have been bent crosswise, through full 180°, without any sign of cracking either in the weld or in the adjacent parent metal.

In the course of experiments conducted at the Hobart Brothers plant, Mr. Bercaw and Mr. Swift tried out various combinations of copper, tin and phosphorus. In some cases the tin was applied as a coating on phosphor-bronze rod. But most satisfactory results were obtained with the special "Hobronz," consisting of copper, tin and phosphorus in certain proportions.

"Hobronz" has also been successfully applied with the carbon arc as a method of "brazing" or "bronze welding." It has also been found to be very effective in welding copper to steel, which application should be of interest to railways that carry coal of high sulphur content. Such railways are faced with high repair and maintenance costs on their coal gondolas due to the action of sulphurous and sulphuric acid resulting from water dripping through the coal onto the steel parts of the car—under-parts as well as body. These gondolas may now be lined with copper and their life thus increased for several years, without abnormal costs for repairs. Manufacturers and users of many chemicals, in addition to constructing vessels of pure copper, may also line their steel vessels with copper at a great saving in construction and maintenance costs.

Get "*H. O. T.*" on Welding

■ Edited by
H. O. T. RIDLON
Welding Consultant, Joliet, Ill.

[This section is dedicated to Better Welding and Better Welding Shops. Suggestions and criticisms are invited.]

Let's Have a National Organization

It has been written by some wise-one, "And out of tumult and disorder will come peace and order," and, I might add, profit for the welding shop and welder, if all the welding shops form an association of National scope with local chapters. Such an organization has been formed in Greater Cincinnati, and is submitting a Code to the NRA. To be really effective, this should be national.

Too long have job shops been unorganized. In union alone is there strength, and if we are to survive we must organize. Bankers and many others have their local and national organizations. Now the time is ripe for job shops to organize and have Uncle Sam as their policeman to force shyster competitors to come in line or quit.

* * *

Hard-Facing Farm Machinery

Yes, indeed, hard-facing or hard-surfacing of farm implements sure does pay profits to the welding shop and to Mr. Farmer. Many requests have come in from all over this wide and broad land of ours, even a letter from 'way up in Moose Jaw, Saskatchewan, Canada, wanting me to talk on this most interesting and profitable subject. It would be much better to get down to cases, but I am forced to generalize on the subject.

Old Mother Nature has many different types of soil on her face, so we must know just what the conditions are before we attempt hard-facing, because one application may be swell one place, and all wet in another. So study your soil and the conditions that must be overcome.

Now get this straight: Apply hard-facing for a condition that is straight erosion. There are many good materials with which to hard-face farm machinery. And the farm is sure a dandy place to fight that war against wear, for you'll win with profits.

The Farm Bureaus have done a lot for us by talking about hard-facing, so it isn't new to Mr. Farmer. But it is hard to sell the idea to some of the boys of spending $5.00 to fix up an old plow share. But a spot about an inch or two along a share will soon convince one that it does pay.

I can hear some of you boys yell you can't get five bucks out of a farmer for doing a share. But, believe me, it can be done. I know a shop in one town who puts on a 50c per pound material and has trouble getting two bucks per share. And in the same town another one of the boys is getting all he can handle at five bucks each. He's using material at $5.00 per pound. But he knows the conditions and how to put it on—also something about selling. For he sells hard-surfacing on the results produced—and that's the only way to sell anything. Also, he is making more profit than his competitor.

The following list from the Stoody Company's pamphlet "Modern Tillage," are some instances where hard-facing pays on the farm: cane-shredder blades, cane knives, burrowing shovels, corn-planter shoes, cultivator shovels, disc-cultivator blades, disc-harrow blades, ensilage-cutter blades, spring-tooth cultivator shovels, spring-tooth harrow shovels, threshing-machine cylinder teeth, harrow teeth, hay cutters, hay hammers, lister shares, mower shares, plow shares, plow points, shredder knives.

The proper process for hard-facing the above list is with the oxyacetylene flame. Use a rod that is highly abrasive-resistant and can be put on very thin (a very important point in the hard facing of farm tools). It should scour well—the polish increases with use.

Remember that hard-facing is *not* revolutionary, but *evolutionary;* that only a few hundred years ago our Pilgrim Fathers had plows of wood, and that it was not until after the War of the Rebellion that they had metal plows.

* * *

Give Complete Details With Your Questions

And was my face red the other day, 'cause from California came a letter about something or other, and the suggestion that I run a question and answer column! Gosh, that's what this column is for. So send in your question and if it is of general interest we'll print it. If not, I'll write you personally. But remember, I'm no mind reader. Tell me the entire story so that I have complete details, including the kind and condition of your welding equipment.

* * *

We Lay Down Our Pen and Hie on to Detroit

My boss says I can go to the National Metal Congress in Detroit, October 2nd to 6th. If any of you fellows are there and want to chat with me, I sure will be mighty happy to get to know you personally. Look me up at either *The Welding Engineer* booth or the Rego booth, for I'll be very much flattered to have you do just that.

Machine Cutting Torches

are used in an ingenious manner for

Slotting Pipe for oil-well casings . . .

■ By W. E. ARCHER

AN INGENIOUS mechanical device, consisting in part of automatic cutting torches, is being used in the manufacture of "screen casing" for oil wells. By means of slots cut into the casing by torches, the oil is screened as it enters the casing from the oil-producing sand near the bottom of the well, and sand, gravel, and other foreign particles are kept out which otherwise would have a tendency to obstruct the flow of oil and reduce the production of the well.

The torches are adjusted to produce undercut slots—that is, the width of the slot is greater on the inside of the casing than on the outside.

Restoring Strength of Pipe by Heat Treatment

The original strength of the pipe is largely retained by specially heat treating the metal adjacent to the slot during the cutting operation, which is said to produce a casing having 96% of the bending strength and 98% of the pulling strength of the original or blank pipe. This process comprises a rearrangement of the microstructure with a refinement of the grain and retention of carbon in sorbitic condition. This is brought about by sudden heating, properly sustained, followed by the sudden quenching due to the flow of this heat to the metal adjacent to the cut. The depth of such refinement is about ⅛ in. It is also claimed that the scleroscope hardness of the surface of the slot is approximately double that of the original metal, and for grade C seamless pipe the hardness is from 50 to 60.

This cutting machine, which is a development of the engineering department of Kobe, Incorporated, of Huntington Park, Calif., manufacturers of oil-well casing, cuts any number of slots from 2 up to 24 in number in any width and length desired. The cutting operations are automatic and the slots are cut simultaneously.

Each cut is started from a drilled hole of a diameter equal to the width of the slot desired. These holes are automatically drilled at the properly spaced positions ahead of the cutting torches, thus eliminating waste of time in a separate operation.

The width and cross-section of the slot are controlled by the number and arrangement of cutting orifices in the torch tip. To produce undercut slots of the usual form in this type of casing, two or more cutting jets of oxygen are used having a spacing and angular relation found by experiment to produce slots of the width and degree of undercut desired. Usually the slot is cut 50% wider on the inside of the pipe than on the outside. This gives a sufficient angle in the slot to readily free any particle that starts through, so the slot will not clog up.

Obtaining Different Slot Widths

The minimum width of slot found practicable to cut is 0.030 in. This requires two cutting orifices having diameters of 0.018 in. The two-orifice type of tip is used for slot widths up to 0.120 in. For widths from 0.120 to 0.180 in., three orifices are used. For greater widths, approximately one orifice is added for each additional 0.060 in. of slot width.

The angle of undercut is controlled by the angle between the jets measured in a plane normal to the longitudinal axis of the slot. This angle of divergence between the walls of the slot can be made from zero to 30°.

The vital part of the tip is made in the form of a small bushing which is easily replaced. The orifices are drilled in this bushing in a drilling jig provided with two micrometer offsets, one vernier angular adjustment, and an indexing device for locating the number of holes desired.

The flame, or preheating, orifices are three or more in number, and lead the cutting orifices. The preheating orifices are drilled in a tip piece having a central orifice into which the cutting bushing is pressed. Four tips for the same slot size are assembled in a turret head.

The cutting torch, which is of special design, is water cooled and of the three-hose type—that is, two hoses supply oxygen and acetylene respectively to the flame for preheating, and the third hose supplies the cutting oxygen. This cutting oxygen is controlled with a separate reducing valve, so that its pressure may be varied without disturbing the flame adjustment. The oxygen and acetylene for the heating flames are held at constant pressure by reducing valves located in the cutting machine, the final adjustment being made by needle valves in the torch. Electrically operated valves turn the oxygen and acetylene supply on and off simultaneously without disturbing the adjustment of the flames.

Cutting Tips Mounted in Turret Heads

An electrically operated valve is also built into each torch for controlling the supply of cutting oxygen to the tip. The tips are mounted on the torch in the turret heads so that any one of the four tips in the turret can be brought into cutting position. In doing so, holes in the turret head register with holes in the torch head, thus completing the gas cir-

cuit to the tip in cutting position and shutting off the gas from the other tips.

Each torch has two position adjustments and a tip distance adjustment. The latter is provided to change the distance between the surface of the tips and the surface of the pipe. With tips designed for a 6° undercut, a variation of 0.010 in. can be made in slot width by varying this tip distance. The normal distance from the tip to the metal is 0.10 in.

Equiped With Special Drilling Heads

Special drilling heads driven by a ¼-hp. motor are a part of the perforating machine. The live spindle carrying the drill chuck is splined and slides through the hollow driving spindle of the motor. The feed of the drill is accomplished by applying air pressure to a piston on the live spindle, the rate of feed being controlled by the amount of pressure applied. A solenoid on the same circuit that supplies the motor operates a slide valve that applies the air pressure behind the piston to feed the drill each time the motor is turned on, and applies air pressure on the other side of the piston to pull the drill out when the power to the drill is turned off. The drills are guided by a bushing close to the pipe and are lubricated by a jet of air with a small amount of oil atomized in it and directed against the drill just below the drill guide. The air and oil are also controlled by the slide valve mentioned above.

The machine proper consists of a carriage mounted on wheels that run on specially machined rails of such length as to permit a travel of approximately 46 ft. This carriage is provided with a 2-speed motor, gear reduction, gear shift, and final drive to a rack attached to one rail so as to give a positive action with four speeds forward and reverse. The carriage also has compartments housing the reducing valves for air and gases, and for the magnetic switches controlling the motors.

Referring to the illustration, the box on the right is the timer which controls the cycle of operations of the entire machine. This is a motor-driven timer with change gears arranged so that the time for the cycle can be varied from 10 to 60 seconds. The timer has a series of adjustable cams which operate the contacts of the control circuits. Manually operated "off" and "on" switches are in series with each of these circuits so that any one circuit, or all of the circuits, can be thrown into operation or cut out, as occasion may demand.

The usual time for the cycle is approximately 20 seconds. This time is divided so as to give ample time for heating and drilling, a definite time for the carriage motor to move the carriage the proper distance, the proper time for the cutting oxygen to produce a slot of the desired length, and time to index the pipe if staggered slots are used. Once this cycle is determined, the machine continues to perform as long as the series-manual control switches are in. Thus the operations are all accurately timed and synchronized and fully automatic. The cams used are of either the fixed or adjustable type, the fixed type being used for slot pattern, or arrangement can be made to conform to any specification with either transverse or longitudinal slots.

As can be seen, rams are provided in the floor which lift the pipe to its position for feeding into the perforating machine. In cutting the slots, the machine starts at the outer, or collar, end of the pipe, and travels toward the head. The rams are lowered one at a time to allow the machine to pass over them.

Maintains High Cutting Speed

The cutting speed while the slot is being formed is 12 to 18 in. per minute. The average time for a 30-ft. joint of casing is one hour from the time the joint is picked up from the sand-blast rack after sand-blasting, until the time it is set on the storage rack on the craneway floor after the slotting operation is completed.

Upon completion of the slotting operation, the casing is thoroughly scaled and cleaned of slag both inside and out. The cutting is so well done by this machine that the finished slot is as smooth or even more so than a milled slot, and the accuracy of the slots as to width is held to a 0.010-in. tolerance, while the slot length is held to within 1/16 in. of the specified length.

The Kobe plant is equipped with six machines similar to the one described herein, and these are located on six parallel tracks. The company also uses these machines extensively for splitting pipe for conduits for telephone and telegraph companies. In this operation only two torches are used—one on either side of the pipe—with a special set-up arranged for this operation. By this method, the pipe is split much more quickly and a better job results than by any other procedure.

"Hot" Ridlon Opens School in Joliet

A welding school, devoted entirely to oxyacetylene welding, again will be conducted this fall by the Barrett Hardware Co., 113 N. Ottawa St., Joliet, Ill., and will be under the able supervision of "Hot" Ridlon, of the company's welding department. "Hot", by the way, is the fellow who conducts the "Get 'HOT' on Welding" column in *The Welding Engineer*. The school will be held Saturdays, 1 to 5 p. m., starting Oct. 21st. The course of instruction will follow that given in "The Welding Encyclopedia," which reference work will also be used as the textbook. About 20 students will be enrolled.

Cleveland School Reports Heavy Demand for Welders

An improved situation as regards employment for welders is indicated by an announcement by Reg. K. Randall, president of the Cleveland School of Welding, Cleveland, Ohio, to the effect that his school received more calls for welders in the month of August than any other month in their seven years of existence. One concern wanted forty-two and another six. Former graduates of the school are being given preference, and the majority of the calls are for combination welders on both arc and gas. Former students who are out of employment should get in touch with the school.

Gas Absorption by Weld Metal

Because the amount of gas absorption during welding has a vital effect upon the finished weld, the Research Laboratories of the Westinghouse Electric & Manufacturing Co. constructed a special welding hood in which the atmosphere may be controlled for the study of gas absorption and in which weld pads can be prepared under any atmosphere. The chemical and gas analysis of the deposited metal gives an indication of the interaction between gases and metals.

At welding temperatures the solubility of metals for gases is generally increased. After the metal cools, some of the previously dissolved gases are given off and cause blow holes. Other gases are not liberated but remain in solid solution. These gases affect the properties of the weld material considerably.

With high-grade coated electrodes the oxygen content near the arc is very low but the nitrogen content is over 90%. However, the nitrogen absorption of the deposited metal is smaller with the higher nitrogen content in the atmosphere. With the use of the welding hood this strange phenomenon of lower nitrogen absorption in an atmosphere of 98% nitrogen as compared with the nitrogen absorption in air was confirmed. This result is of enormous importance to the welding industry because it discloses some of the mechanism of absorption by weld metal. It shows that molecular nitrogen is hardly dissociated at iron-arc temperatures. It must therefore be assumed that nitrogen is absorbed by the weld metal only when it is in the form of an active nitrogen-oxygen compound.

Program of Convention of International Acetylene Association

To Be Held in Gold Room, Congress Hotel, Chicago, September 26th to 29th

Tuesday, September 26th

9:00 a.m. Registration begins in the Gold Room, Congress Hotel.

10:00 a.m. The Oxyacetylene Industry—1836 to 1936. Chairman—E. J. Hayden, President.

Address of Welcome, by the Honorable Edward J. Kelly, Mayor of Chicago.

Keynote Address, by Bennett Chappell, The American Rolling Mills Co.

President's Address, by E. J. Hayden, The Linde Air Products Co.

"A Century of Progress in Acetylene," by the Honorable John Motley Morehead, of New York.

Oxyacetylene Committee Report, submitted by J. J. Crowe, Air Reduction Sales Co.

Wednesday, September 27th

10:00 a.m. Railroads and the Oxyacetylene Process. Chairman—Lem Adams, Chief Engineer, The Oxweld Railroad Service Co. Vice-Chairman—W. H. Ludington, Air Reduction Sales Co.

"Heat Treatment by the Oxyacetylene Process," by J. H. Critchett, Vice-President, Union Carbide & Carbon Research Laboratories, Inc.

"Reconditioning Rail Ends," by J. C. Hartley, Pennsylvania Railroad.

"Profitable Scrapping of Locomotives and Cars," by A. L. Prentice, Manager, Scrap and Reclamation Department, New York Central Railroad, Cleveland.

"Importance of the Oxyacetylene Process in Developing Rolling Stock Designs," by G. S. Edmonds, Superintendent of Motive Power, Delaware & Hudson Railroad, Albany, N. Y.

"Welding and Cutting in Refrigeration and Air Conditioning," by W. Campbell, Servel Company.

"Air Conditioning in Passenger Cars," by representative from The Pullman Car & Manufacturing Corp.

Discussion—Led by F. C. Hasse, of The Oxweld Railroad Service Co.

8:15 p.m. Meeting at the Goodman Memorial Theater, East Monroe St. and South Parkway. Presiding—E. J. Hayden, President. Vice-Chairman—H. E. Pearson, Vice-President.

Address by A. Cressy Morrison, of New York.

Presentation of Morehead Medal, by E. J. Hayden.

Acceptance of Morehead Medal, by the Reverend Julius Arthur Nieuwland, C.S.C., Ph.D., Sc.D., Professor of Organic Chemistry, University of Notre Dame.

"The Prosperity Process" (an Industrial Drama in Four Acts), by John P. Waters.

CAST OF CHARACTERS
(in order of their appearance)

JOHN BORDEN, *President, Central Manufacturing Co.* ..... T. M. Hamer
DORA BLANK, *President's Secretary* Miss Betty Renner
JIM DRIVER, *Sales Manager* ..... W. S. Farr
OTIS DODGE, *Works Manager* ..... John J. Crowe
HUGH WYNN, *Salesman for Keystone Welding Equipment Co.* ..... H. H. Moss
KENNETH KEENE, *Welding Engineer for Keystone Equipment Co.* ..... A. B. Kinzel
FRANK JONES, *Assistant Works Manager* ..... F. G. Outcalt
JASPER BULL, *a welder* ..... E. C. Turner
PETE HALL, *a welder* ..... W. B. Browning
TOM STRONG, *a welder* ..... J. Franzen
EARL PETERS, *a welder* ..... C. V. Eskridge

Act One—John Borden's office. Time, the present.
Act Two—Otis Dodge's office, the next day.
Act Three—The plant welding shop, half an hour later.
Act Four—John Borden's office, six weeks later.

Thursday, September 28th

10:00 a.m. Acetylene and Oxygen in Education and Research. Chairman—John C. Penn, Dean of Engineering, Armour Institute of Technology. Vice-Chairman—A. B. Kinzel, Chief Metallurgist, Union Carbide & Carbon Research Laboratories.

"Basic Research Possibilities in Acetylene and Calcium Carbide," by the Reverend Julius A. Nieuwland, University of Notre Dame.

"Importance of Welding and Cutting in Engineering Education," by H. A. Frommelt, Head of School of Mechanical Engineering, Marquette University, Milwaukee.

"Future Construction With Welding," by Stephen Timoshenko, Professor of Mechanical Engineering, University of Michigan.

"Importance of the Technician's and Welder's Ingenuity," by G. O. Carter, Consulting Engineer, The Linde Air Products Co.

Discussion—Led by A. Cressy Morrison, of New York.

Friday, September 29th

2:00 p.m. Modern Metals, Alloys and the Oxyacetylene Process. Chairman—E. E. Thum, Editor, *Metal Progress*. Vice-Chairman, E. L. Mills, Vice-President, The Bastian-Blessing Co.

"Rehabilitating the Brewing Industry," by J. W. Rabe, Assistant Chief Engineer, Anheuser-Busch, Inc.

"Pipe Welds and Weld Tests," by F. C. Fantz, Vice-President, Midwest Piping & Supply Co., Inc.

"Fabricating Alloy Steels for the Process Industries," by R. S. McBride, Associate Editor, *Chemical & Metallurgical Engineering*.

"Production of Steel Equipment by the Welding Process," by H. G. Marsh, Carnegie Steel Co.

"Metals Coating," by R. I. Binder, President, Metals Coating Co. of America.

Discussion—Led by H. L. Whittemore, Bureau of Standards.

4:15 p.m. General Business Session. Chairman—E. J. Hayden, President.

Report of the Consulting Engineer, by J. I. Banash.

Report of the Secretary, by H. F. Reinhard.

Report of the Treasurer, by W. E. Cotter.

Report of the Auditing Committee, by Philip Kearney.

Reports of the Legislative and Insurance Committee, and of the Technical and Engineering Committee, by H. S. Smith.

Report of Resolutions Committee and Nominating Committee, by L. E. Ogden.

Election of Officers.

6:45 p.m. Annual Banquet, held in the Gold Room, Congress Hotel. Entertainment and dancing.

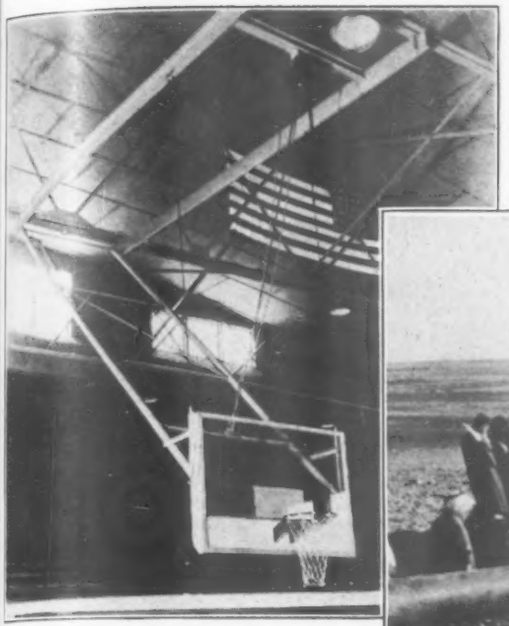
Regulations Covering Boiler Repairs

Gas or arc welding can be applied to the repairing of boilers and other pressure vessels wherever the stress is carried by other construction conforming to the A. S. M. E. boiler code and where the safety of the boiler or vessel is not dependent upon the strength of the weld, according to regulations outlined in a leaflet issued by the National Bureau of Casualty & Surety Underwriters, 1 Park Ave., New York, N. Y. This regulation in no wise applies to cases covered by the code itself but is intended to supplement the code, which has already been adopted by the Executive Committee of the National Board of Boiler and Pressure Vessel Inspectors. The leaflet announcing this ruling gives nine examples illustrating its application to typical cases.

Brewers' Convention and Exposition

The American Exposition of Brewing Machinery, Materials and Products will be held at the Coliseum, Chicago, from September 23rd to 30th, inclusive. The electric and oxyacetylene welding of Everdur metal and the latest methods of brazing copper will be demonstrated by The American Brass Co. in space No. 74 and 75 at this exposition.

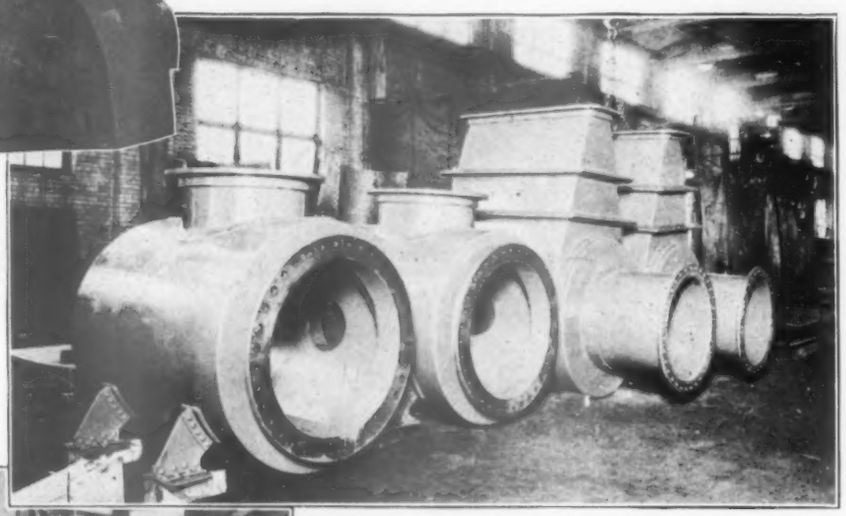
WELDING NEWS
▪ IN PICTURES ▪



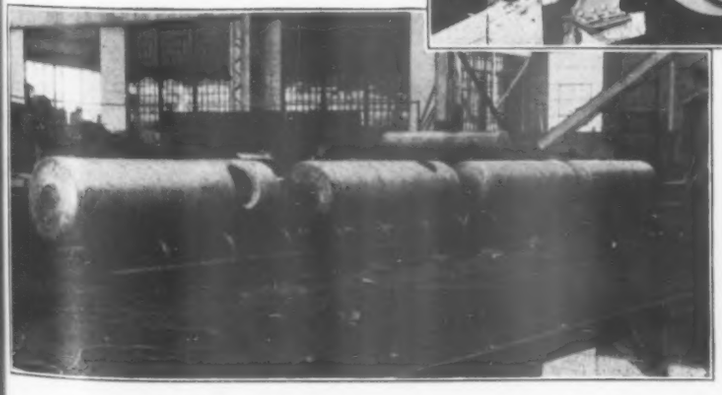
It may not help the local team win, but this all-welded framework on the basket-ball backboard has advantages in economy, weight and rigidity. Built of tubes by the Wallace Steel & Supply Co., Lafayette, Ind.

Natives of Palestine follow the welding crews on the Iraq pipeline and marvel at the wonders of the electric arc. This line will carry oil from the rich fields of Iraq (formerly Mesopotamia) to the ports of Haifa and Tripoli on the Mediterranean. (Photo by courtesy of The Lincoln Electric Co.)

A job any welder can be proud of. This heavy casting from an alligator shear, repaired by preheating and oxyacetylene welding, is rendered good as new. Work done by the Toledo Welding Co., Toledo, Ohio.



Speaking of neat jobs, here's a pippin! Valve bodies for water main made from ½-in. plate with all joints arc welded. (Photo by courtesy of Muskegon Boiler Works, Muskegon, Mich.)



All-welded carbon-dioxide tanks, each 10 feet long, for brewery service, at 250-lb. working pressure. Built by the Chicago Bridge & Iron Works in accordance with A.S.M.E. code requirements for Class 2 pressure vessels.

Fig. 1. 750-Gallon Aluminum Truck-Tank and Trailer Frame.

(Fabricated from 3S½ hard plate with torch-welded joints. Weighs 3535 lb., with an estimated saving over steel construction of 1920 lb. for the completed unit. Tank built by the Davis Welding & Mfg. Co., Cincinnati, and trailer by the Freuhauf Trailer Co.)

Welding the Aluminum Alloys

■ By G. O. HOGLUND
Aluminum Company of America

ANY discussion of the joining of the wrought aluminum alloys by welding should consider first the characteristics and physical properties of these alloys, for it is as true with these materials as with the ferrous alloys that the change in structure due to the application of the welding heat affects the properties of the alloys. This discussion will cover only the welding of the wrought aluminum alloys as distinguished from the cast alloys, though the technique and methods are in many cases the same.

In considering the effect of welding, the wrought alloys can be divided into two groups, the "cold-worked" and the "heat-treatable" alloys. The physical properties of the commonly used alloys are listed in Table I and are divided on the basis given above.

It is evident that there is a considerable range of mechanical properties available in the cold-worked alloys which is obtained entirely by varying the amount of cold plastic deformation in fabricating the material in the mill. The strength of welded joints in these alloys is dependent on the strength first of the cast material in the weld and, second, of the area near the weld which has been affected by the welding heat.

Breaks Occur Only in Annealed Zones

Tensile tests on welded joints in any of the cold-worked alloys that have been welded with the correct technique will always show breaks outside of the weld. In other words, the cast-metal zone is not the weakest point. The breaks occur in an area having a width from 2 to 5 times the thickness of the material, on either side of the weld; and regardless of the temper or amount of cold work the alloy has received, the strength will be equal to the annealed properties of the alloy. It follows that designs, such as pressure tanks, which load the welds in tension, should be based on the annealed properties of the material. Welded joints in other types of structure may not be loaded in this manner or may not be placed at the points of greatest stress, and advantage can then be taken of the strength of the intermediate tempers.

No such generalizations can be applied in the case of the heat-treatable aluminum alloys. A zone near the weld is affected by the welding heat but the action is not such as to anneal the metal completely, and sometimes it is possible to reduce this effect considerably by re heat treatment.

The conventional methods of fusion or electric resistance welding can be readily adapted in the fabrication of the aluminum alloys. Torch and arc welding have been used commercially for some time; and recently, spot and seam welding have been developed to the point where they are practicable for use with aluminum.

Procedure for Torch Welding

The use of either an oxy-hydrogen or oxy-acetylene flame is adaptable to the torch welding of aluminum alloys. From the standpoint of strength or soundness of welds, there is little to choose between these two gases, except in the lighter gages, 0.050-in. and under, where the oxy-hydrogen flame is somewhat superior, particularly in inexperienced hands. On material heavier than 0.250 in., oxy-acetylene is universally applied as the higher flame temperature causes faster melting and greater welding speeds. A neutral flame or one that is slightly reducing should be used in either case.

All the aluminum alloys have a surface oxide coating that is sufficiently dense and refractory to prevent the flow of the molten metal into a sound weld. The most practicable way of removing this coating is by the use of a suitable flux, of which there are several on the market. The flux is usually available in powdered form. It is mixed with water and applied either by brushing on the joint to be welded or by dipping the welding wire in the flux just prior to the welding operation.

A filler rod is used for most welding

Table I—Typical Mechanical Properties of the Wrought Aluminum Alloys[1]

Alloy and Temper [2]	TENSION: Yield Strength, lb./sq. in. [3]	TENSION: Ultimate Strength, lb./sq. in.	TENSION: Elongation per cent in 2 in.	HARDNESS: Brinell Hardness, 500 kg.-10 mm. ball	SHEAR [4]: Shearing Strength, lb./sq. in.	FATIGUE [5]: Endurance Limit, lb./sq. in.
2SO	4,000	13,000	35	23	9,600	5,000
2S½H	14,000	17,000	7	32	11,000	7,000
2SH	21,000	24,000	5	44	13,000	8,500
3SO	5,000	16,000	30	28	11,000	6,000
3S½H	18,000	21,000	6	40	14,000	9,000
3SH	25,000	29,000	4	55	16,000	10,000
4SO	10,000	26,000	20	45	16,000	14,000
4S½H	31,000	35,000	5	65	19,500	15,000
4SH	38,000	42,000	3	80	23,000	16,000
17ST	35,000	58,000	20	100	35,000	15,000
51SO	5,500	16,000	30	28	11,000	6,000
51SW	20,000	35,000	24	64	23,500	10,500
51ST	38,000	48,000	14	95	30,000	10,500
53SO	9,000	17,000	25	..	.....	.....
53SW	18,000	29,000	22	67	22,000	.....
53ST	30,000	35,000	12	86	26,000	.....

(1) Young's modulus of elasticity is approximately 10,000,000 lb. per sq. in.
(2) "O" indicates annealed condition; "H", hard worked; "W", heat treated and quenched; "T", heat treated, quenched and aged.
(3) Stress at which stress-strain curve departs 0.2% from the initial modulus line produced. The yield strength in compression is substantially equal to the yield strength in tension for wrought alloys.
(4) Single-shear strength values obtained from double-shear tests.
(5) R. R. Moore type of rotating beam machine; endurance limit based on 500,000,000 cycles.

erations. On commercially pure aluminum and on 2S and 3S alloys, the composition of the rod is generally 2S, particularly on parts where the welds must be finished and show the same color as the parent material. On the other cold-worked alloys and on all the heat-treatable alloys, the use of an aluminum-silicon alloy containing 5% silicon is recommended as filler rod. In preparing the joints for welding, it is common practice on gages of material below 0.051-in. to flange the joint to a height about equal to the gage of the parts and melt down the flange with no application of filler rod.

In making butt joints, no preparation is necessary on material up to 3/32 in. thick to obtain complete penetration. Cold-chisel notches spaced 1/8 in. apart are often used, however, to speed up the welding operation and yet get good penetration. On heavier material, the edges are usually cut to form a butt joint of the single-V type having an included angle of between 70° to 90°. On ¼-in. thick material, or thicker, double-V joints are used.

An early application of torch welding with which everyone is familiar is on aluminum cooking utensils, and it is this field which served as a proving ground for the process. At the present time, however, the field has expanded greatly. A truck-tank trailer unit on which the tanks were made from aluminum alloy plate with torch-welded joints, is shown in Fig. 1.

Welding With the Metallic and Carbon Arcs

The process of welding aluminum alloys by the carbon- and metallic-arc methods has been developed more recently. Of these two, the metallic arc is the more widely applied, for the reason that it is somewhat easier to handle in manual welding. The carbon arc, however, appears to offer considerable promise where production warrants automatic welding methods. As we are treating only established practices, however, the following description will concern only metallic-arc welding.

Table II—Electrode Size and Machine Setting for Metallic Arc Welding Aluminum

Thickness (In.)	Electrode Diameter, (In.)	Amperes
0.064	1/8	45-55
0.081	1/8	55-65
0.102	1/8	65-75
0.125	1/8	75-85
5/64	1/8 or 5/64	85-100
3/32	5/64	100-125
1/4	5/64 or 3/32	125-175
5/32	3/32	175-225
3/8	1/4	225-300

Practically all the standard d.c. arc-welding machines are suitable for use in welding aluminum without any changes. If the machine is not of the type having a high degree of arc stability, it is desirable to include a resistance of 1/3 to 1/2 ohm in series with the arc when welding metal 1/8 in. in gage or lighter. Either straight or reversed polarity can be used, though the location and type of weld will usually determine which polarity is the better. This can be readily ascertained by the operator in a single trial.

A.c. welding equipment, particularly the type with a superimposed high-frequency current on the welding circuit, is also suitable for welding aluminum.

A flux-coated rod is used in metallic-arc welding any of the aluminum alloys. There are several suitable rods on the market at present, varying in diameter from 3/32 to 1/4 in. The gage of the material to be welded determines the best rod size. Table II lists recommended rod diameters as well as current settings as a function of the gage. All the aluminum alloys have similar characteristics from this standpoint and the table can be applied generally.

The technique of making arc welds in the aluminum alloys is not essentially different from practices on other materials. After the arc is established, it is shortened as much as possible. The electrode is advanced along the joint in a straightforward or backward motion with no weaving. Butt welds on metal up to 1/4-in. gage are made with no preliminary veeing or notching, and such joints should be backed with back-up plates to prevent the formation of holes. Heavier material is veed, leaving a 1/8-in. to 3/16-in. lip at the bottom of the vee.

Fig. 3. Plan and Sectional Views of Spot-Welded Bulkhead Panel.

(Made from 0.048-in. 3S¼ hard flat sheet and 0.024-in. 3S½ hard corrugated sheet. Spot welded without indenting outside surfaces. The marks showing on the surfaces are discolorations rather than indentations.)

Less Distortion and Higher Speed Obtained With the Arc

The chief advantages of this method of welding are the speed with which it can be accomplished, the minimizing of distortion, and the narrowing of the area affected by the welding heat. The high thermal conductivity and expansivity of aluminum combine in torch welding to introduce distortion into the structure and affect the physical properties of the material near the weld. These factors are improved, to a considerable extent, by the concentrated high-temperature zone of the arc.

The welding of some of the heat-treatable alloys is practicable only if arc welding is applied, as the tendency of these alloys to be hot-short at elevated temperatures introduces cracks in the parent metal near the weld when a torch is used. The cost of torch-welding and arc-welding operations is approxi-

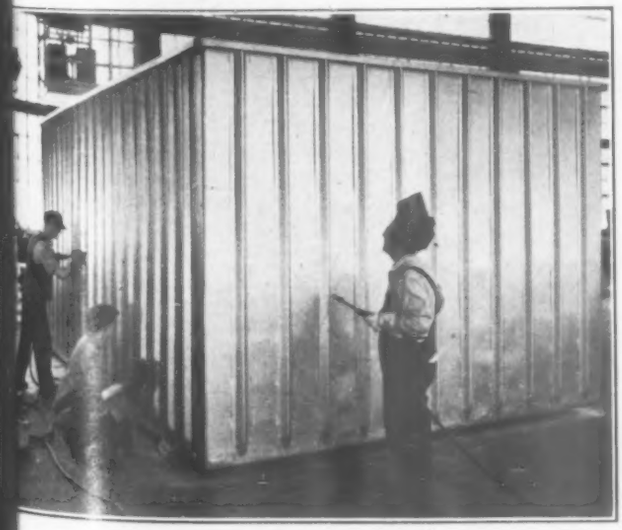


Fig. 2. 15,700-Gallon Aluminum Tank with Flanged Stiffeners.

(The joints are gas welded, while the stiffeners are tack welded with the metallic arc to minimize distortion in the side-walls.)

mately the same. This conclusion is based entirely on manual welding. The development of automatic welding operations will undoubtedly reduce the costs considerably.

Metallic-arc welding has been used in welding stiffener members to large tanks as shown in Fig. 2, also in the welding of brackets and frames on electric locomotives, the leak-proofing of seams on tank cars, to mend broken or defective castings, and in many other applications. The service testing of this equipment has been satisfactory, and it seems quite likely that the applications of this method of welding will continue to increase.

Fig. 4. Typical Spot-Welded Fittings for Cooking Utensils.
(Produced by The Aluminum Cooking Utensil Co., New Kensington, Pa.)

Spot-Welding Method in Wide Use

The resistance welding method that has been applied most widely is spot welding. An example is shown in Fig. 3, which depicts a bulkhead panel on which the spot welds have been made so as to be practically invisible after applying a coat of paint. Fig. 4 illustrates typical spot-welded fittings as applied in the cooking-utensil field.

The high electrical and thermal conductivity of aluminum alloys combine to require a high machine capacity and a short current timing period to obtain sound welds. From two to two and one-half times as much current is required at the spot-welding tips to make welds in aluminum alloys as is required in welding the same thickness of low-carbon steel. In addition, the presence of a dense refractory oxide film on the surface of the aluminum alloys prevents the fusion of two pieces under pressure, unless the temperature is sufficiently high to form a molten bubble. To obtain consistent welds in aluminum alloys, the equipment used should deliver a short but definitely controlled current application at predetermined pressures.

Except in certain cases, standard commercial equipment designed for use on steel cannot be applied to welding aluminum. Extensive experiments have shown that the duration of the current with the conventional mechanically actuated contactors is not consistent in successive spots, particularly in the range where one or two cycles are required to make a spot. In addition, the application of current with such equipment is made without reference to the point of the wave in either making or breaking the circuit.

Improved results are being obtained with synchronously timed power application which cuts in the welding current at a definite point on the wave and cuts it off after a definite interval. Excellent results have been obtained with both mechanical and vacuum-tube synchronous control equipment, and commercial machines operating on one or the other method are on the market. Fig. 5 illustrates an installation utilizing electronic control for timing the spot-welding current. In addition to timing the current, the pressure between the tips must be controlled. Most successful results have been obtained with pneumatic or hydraulic devices. Table III shows the approximate pressure, time and current recommended for spot welding the aluminum alloys.

There are a number of other details which contribute to successful operations. Practical experience has shown

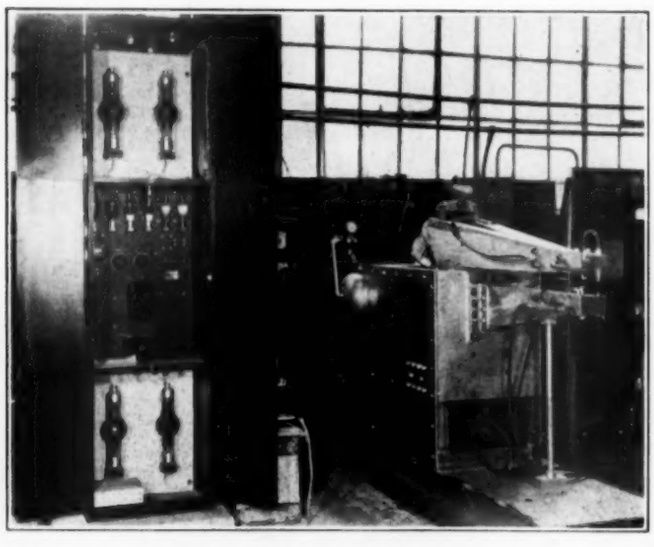


Fig. 5. Spot Welder and Electronic Timing Panel.
(The welder itself is built of aluminum with a 36-in. throat and is rated at 200 kva. The timing panel shown at the left, is suitable for handling 700 kva. when loaded intermittently or 375 kva. when loaded continuously.)

hard-drawn copper rod to be most suitable as a tip material, or a copper alloy in which the electrical conductivity is above 75%. Such tips must be water-cooled to prevent alloying between the aluminum alloy and the tips. In spite of the best cooling, however, alloying and pick-up on the tips will occur; and if the surface of the spot is to be kept smooth, the tips must be cleaned at more frequent intervals than is the case with spot welding steel.

The oxide coating on the aluminum sometimes interferes with the welding process. This is not so true of the cold-worked alloys as of the heat-treated alloys, which have a denser, thicker insulating coating which offers sufficient resistance to raise the temperature of the surface and cause pick-up on the tips. The coating is easily removed by abrasive wheels, emery cloth or steel wool. It is almost standard practice to remove the oxide coating on the outside surfaces and sometimes on one inside surface.

Pressure-Tight Joints Obtained by Seam Welding

The process of seam or line welding the aluminum alloys has only recently been made possible by the development of suitable control equipment. The process is essentially one of over-lapping spot welds along a line to make a continuous pressure-tight joint. The welding current is applied to the joint through two rotating wheels under pressure, and the problem has been to make and break the circuit at definite intervals. No mechanical make-and-break device could be found that would handle the capacity required to weld aluminum at the speeds necessary. The introd

Table III—Recommended Pressure, Time and Current for Spot Welding the Aluminum Alloys

Thickness, (In.)	Time* (Cycles)	Welding Current (Amperes)	Electrode Pressure (Lbs.)
.020	1	15,000	200-300
.032	1-2	17,000	300-400
.051	2-3	19,000	400-500
.064	3-4	22,000	450-550
.081	5-6	26,000	550-650
.101	6-7	30,000	600-800
.125	8-10	35,000	800-1000

*Based on 60 cycles per second.

n of vacuum-tube control, mentioned r spot welding, has effectively solved s problem, and excellent results are ing obtained with the timing equipnt shown in Fig. 5.

The previously outlined requirements the comparatively high capacity ded for spot welding aluminum alloys ply also to seam welding. In addition, presence of the fused metal adjacent the point being welded provides a th for the current to shunt back rough the weld, so that seam welding uires even greater capacity than uld be required for spot welding the ne gage of material. The process is such recent origin that the whole field s not been thoroughly investigated, t results at present indicate that the io of time-on to time-off of welding rrent should be about 1-to-3. The best sults have been obtained with 1 cycle 3 off, 2 on 6 off, 3 on 8 off, 4 on 10 , depending on the gage of the mate-l. For pressure-tight joints, the wheel ed is adjusted to make from 10 to 13 ts per inch. For example, on 0.051- material, liquid-tight joints were le with a timing cycle of 1 cycle on cycles off. The welding speed was 6 ft. r minute and a pressure of 1240 lb. s used on the wheels.

The process of seam welding is similar spot welding in that copper has so r given the best results as the material r the wheels constituting the elec-des. The previous remarks on the ef-t of the oxide coating on the alumi-m alloys apply also to seam welding, d the problem of wheel pick-up is not pparent if a clean contact surface is ovided on the outside of the sheet.

hicago Visitors Can't ind Time to Sleep

Louis W. Stettner, president of the tor Welding Equipment Co. on the cific Coast, and Mrs. Stettner, recently nt a week in Chicago taking in the orld's Fair and various night clubs. e party was augmented by E. A. niels, sales manager of the Victor mpany. Their friends are wondering y they had a hotel apartment since y had little if any sleep while in the Windy City." Charley Harter, presi-nt of the Welders Supply Co. of Tulsa d Dallas, who with Mrs. Harter was in icago at the same time, is reported to ve warned Louis that if he spent any e sleeping he might miss something, d hence the vacant hotel suite which uis paid for.

It has been suggested that those mak-g last-minute hotel reservations for the A. A. meeting in Chicago and having scout up side-streets and walled-in ayons for vacant rooms might find some nsolation in this story. Many, like the sitors from the Pacific Coast, will use otel rooms only as an address anyway.

Gas Welding Group to Meet in Chicago

The National Oxygen & Acetylene Association, which has drawn up a "code of fair practice" for the manufacturers of oxy-acetylene welding and cutting equipment and supplies, will hold business meetings in Chicago on the afternoons of September 26th, 27th, and 28th. The headquarters of the Association is at 75 E. Wacker Drive, Chicago.

J. W. Gray Dies of Injuries

The death of Jesse W. Gray, welding specialist, Westinghouse Electric & Manufacturing Co., New York, occurred on July 8th at Tyrone, Pa., as a result of injuries sustained in an automobile accident near Altoona. He was 28 years of age.

Mr. Gray specialized in the study of electric welding. After a period of training, he took up actual welding work in the Westinghouse shop, later becoming an instructor in the welding school. At the time of his transfer to the New York office of the company in April, 1930, he was an inspector of welding in the East Pittsburgh shop. As a welding specialist he did very excellent work in helping a number of users of welding equipment to adopt electric welding to many new and special applications.

JESSE W. GRAY

Straightening the Kinked Ends of Stainless Wire

A scheme for straightening the kinked and bent ends of coils of stainless-steel wire, thus making it possible to utilize these ends, is being used by Maurath, Inc, Cleveland, Ohio, manufacturers of stainless-steel welding electrodes.

In every coil of stainless-steel wire, for a distance of from 5 to 20 ft. from each end there are kinks and bends, making it difficult to turn these ends into salable stainless wire, and yet, to discard them would result in a considerable loss.

Each of such pieces is now being straightened by fastening to each end a wire-puller dog, to one of which is attached a block and tackle. The ground of a 300-ampere arc welder is fastened inside one of the dogs, and the electrode holder inside the dog at the other end. The welder is turned on and in a few seconds the current heats the wire to a red heat, whereupon a pull on the block and tackle straightens the wire perfectly. This operation reduces the diameter of the wire only 0.001 in. and requires only about two minutes to perform.

Large Water-Line Project to Be Welded

A large all-welded water-line project is about to be undertaken by the Bureau of Water and Power for the city of Los Angeles, Calif. This pipeline, which will range from 80 to 94 in. in diameter and will be about 4 miles long, is to be laid in Bouquet Canyon, which is situated about 50 miles north of the city of Los Angeles.

The thickness of the plate to be used in fabricating the pipe will range from 3/8 to 1-1/16 in. and 4500 tons will be required. The contract for the fabrication of the pipe has been awarded to the Western Pipe & Steel Co., of Los Angeles, who will employ automatic electric welding throughout. Installation of the line will be handled entirely by the Water and Power Department of the city of Los Angeles.

Arrangements have been made for the use of ten 400-ampere motor-driven electric welding units for this work, which comprises one of the most important welding projects for this year in southern California, and the city will probably ultimately purchase these welding machines outright.

New Specifications on Filler Metal

Intended to supersede the present "Welding Wire Specifications," a report on "Tentative Specifications for Filler Metal" has been submitted to the American Welding Society by the Welding Wire Specifications Committee, of which C. A. McCune is chairman, and is now available in printed form.

Whereas the present specifications are based on the chemical composition of the filler metal, these new tentative specifications are based on the physical properties of the weld produced by the filler metal. Physical characteristics are determined by prescribed tests on welded-joint specimens and on deposited-metal specimens. The specifications also cover inspection, packing, marking, and ordering of electrodes, rods, and wire.

Wanted: A National Code—(An Editorial)

PROGRESS in the organizing of welding shops under the "new deal" is being reported from various sections of the country.

The Welding Contractors Association of America has drawn up a code for welding contractors and job shops, copies of which can be obtained from the offices of the association in Room 517, 522 Fifth Ave., New York, N. Y. S. N. Clarkson, managing director of the Association, points out that this code conforms to the labor provisions in the code of the Construction League of the United States as submitted to the NRA, to which code the welding contractors' code may have to be supplementary. Efforts are being made by the Welding Contractors Association to enlist all contractors and job shops employing welding in any part of the country behind this code through the organizing of local associations.

Another organization of national character, to include welding contractors and job welding shops, is the Welding Institute, which has been incorporated under the laws of the state of Delaware. Because the matter of ethics and fair practice rates is considered to be local in character, the Institute will divide the country into regional districts, and each district will make fair practice rate schedules to be approved by the national body, who in turn will collect data having a bearing on and justifying such schedules. Printed copies of the code framed by the Institute can be obtained from John B. Hendrickson, of John B. Hendrickson, Inc., 225 South 15th St., Philadelphia, Pa.

On August 17th there was organized in Cincinnati, Ohio, an association of owners of welding shops called The Greater Cincinnati Commercial Welders Association. The purpose of the organization is to develop a "code of fair competition," which work has already been completed, and to further the advancement of welding and of good fellowship among the shops. The meeting was held in the oldest welding shop in the city, which is the Cincinnati Welding & Repair Co., 412 Richmond St., owned by Robert Herbert, who is a charter member of the new organization. Any one interested can obtain a copy of the Cincinnati welders' code by writing R. Michels, of the R. Michels Welding & Supply Co., 720 Washington St., Covington, Ky.

In Lorain, Ohio, the welders and body-shop operators are also organizing to work out a code which will conform to the Industrial Recovery Act.

Southern California is also organizing. Welders, welding-shop owners, and other concerns doing commercial welding have joined together to form the Welding Committee of San Diego County (Calif.). This Committee will operate in conjunction with the San Diego Automotive Association, whose secretary, Lawrence Smith, is also secretary of the new organization. The other officers of this Committee are: chairman, H. K. Shockey, of the Shockey Welding & Boiler Works, San Diego; and vice-chairman, A. P. Hoine, of the West Coast Gas Engine Co., San Diego. The territory covered by this new organization includes the city of San Diego and other industrial centers in San Diego County. A "code of fair competition" has been adopted.

Another organization, known as the Southern California Welding Trade Association, is being formed by welding shops throughout the territory lying south of the city of Bakersfield and within the state limits. By-laws and a constitution have been drawn up and approved and a code is being prepared. Chas. N. Rapfogel, owner of the Acme Welding Works, Los Angeles, is temporary chairman of the new organization, and W. T. Wheeling, secretary of the National Electric Welding Corp., Huntington Park, is temporary secretary.

Movements are under way in Chicago, Atlanta, Buffalo, and other cities to call the welding-shop owners together into an organization.

A code to receive consideration by the administrators of the NIRA should be approved by a sufficient number of those in the industry to which the code pertains, and these should represent a sufficiently wide geographical distribution, as to indicate that the code is representative of what the industry wants.

So that the submitting of a code will not be unduly delayed, it is urgent that the welders take immediate steps to organize in all industrial areas and in outlying communities. They may organize as an independent group or affiliated with one of the groups mentioned above. Ultimately, all these groups will be brought into a national association of welding shops (perhaps also including welding contractors).

At present, the only way to effect local organizations is for some shop owner or welder in each community to take the initiative and call a meeting of all concerns who will operate together under a code. A code can be drawn up any time after the organization is completed.

If the codes of individual groups are not in agreement, the drafting of a code on which all can agree will rest with some national organization composed of all the groups concerned.

The imperative need just at this time is for a universal agreement on some one code. If each isolated association of welders and shop owners sends in its own code to Washington, it will only succeed in delaying matters, for there will be no code approved by the NRA until it has been approved, by and large, by the individual welding-shop associations now being organized throughout the country. *If the shop owners desire a code of their own—one which they have had a part in framing—they must act speedily and all act together.*

To stand the best chance for quick adoption by the many groups, such a code should be brief and should have eliminated from it any minor details that might be confusing or controversial. Briefness and simplicity of statement are necessary, even at the expense of a little hardship worked here and there. After such a code is framed, and if general approval is shown, there is no necessity for any individual to withhold his signature of adherence to the code by reason of any fear that some provision in the code will operate to his disadvantage, since the NRA is ready at all times to consider individual situations where great and unavoidable hardship is produced by code provisions and to grant exemptions where an impartial investigation upholds the claim of the petitioner.

Commenting on the Cincinnati organization, Mr. Michels states, "I personally have tried for the past fifteen years to get something of this kind in the Cincinnati territory, but it has always received cold water, as the owners of most of the shops here are former workmen of the older shops, and they were reticent about meeting with and making arrangements with their former bosses in an attempt to set up conditions under which they could all work satisfactorily. Now that this situation has come up, and they find that they have to get together on a common basis, it has turned out to be one of the finest things that they ever thought of, and several have expressed the opinion that it could have been done ten years ago. So I have come to the conclusion that the welding trade only lacks *leadership*."

This opinion may encourage those who find similar conditions existing in their communities.

New Equipment

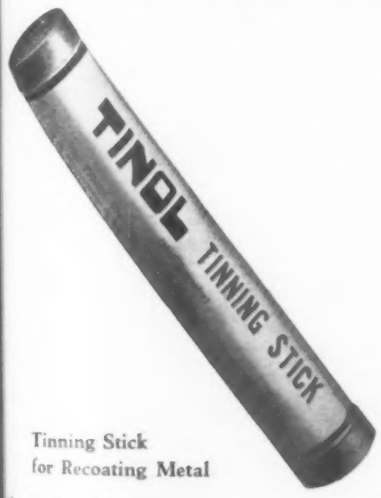
"Bingrod" for Hard-Surfacing

A hard-surfacing welding rod known as "Bingrod", invented by Walter S. Bingham, of Cassopolis, Mich., is being produced and marketed by him. In a pamphlet describing the rod and giving directions for applying it, it is stated that the rod insures two to four times the wear on steel or cast-iron plow points, cultivator shovels or other wearing edges and surfaces.

New Tinning Compound in Stick and Powder Form

A tinning stick containing fluxing ingredients of unusual penetrating power is being marketed by the American Solder & Flux Co., Wayne Ave. and Berkley St., Philadelphia, Pa. It is claimed that this new stick can be used effectively on surfaces coated with rust, grease, paint, or almost any other substance without cleaning the surface, and it is said to lay down a perfect tin surface on all metals or their alloys without any previous preparation. Thus, any solder operation can be quickly completed regardless of the metal or its condition.

The same product is available in the form of a powder that may be used to recoat metal that has been welded and



Tinning Stick for Recoating Metal

the coating burned away by reason of the heat. It comes in four brands: Brand "A" for re-tinning, Brand "B" for re-soldering, Brand "C" for re-leading, and Brand "D" for re-galvanizing. The powder may be mixed with water and applied with a brush or it may be sprinkled on the surface to be coated and then heated. Since the material contains its own flux, it only need be applied and heated.

All-Purpose Aluminum Welding Rods

The "Almare" electrodes, made by Wooldridge & Larson, 195 Naubuc Ave., Glastonbury, Conn., have been developed into all-purpose aluminum welding rods for gas as well as arc welding, says an announcement from the company. It is also stated that the company's "Alflux No. 2," which is recommended for use with their 5% silicon gas-welding rod, has been tested and approved by the Aluminum Co. of America, as well as in preliminary tests by the Naval Bureau of Aeronautics.

Fully Enclosed Welder Has Wide Welding Range

High arc stability, wide welding range, and effective protection against dust, moisture or falling objects, are claimed for the new USL "Protected-Arc" welder recently announced by the USL Battery Corp., Niagara Falls, N. Y.

A new design of stabilizing coil is said to produce a very high arc stability and quick voltage recovery, reducing current lag to the very minimum. Two convenient current and voltage controls permit any voltage and current combination desired. The convenient location of the welding leads allows quick reversal of polarity. By making a dual adjustment, it is possible to weld the thinnest automobile body or the heaviest locomotive frame.

The new welder is rated at 40 volts and has an open-circuit voltage rating of

New "Protected-Arc" Welder

25 to 80. It has a welding range of 40 to 550 amperes, assuring ample overload capacity.

Heavy-duty ball bearings are employed. The complete mechanism and wiring are enclosed in a heavy sheet-steel cylinder equipped with a hinged steel cover on the commutator end of the machine. The fan and ventilating system are said to be of ample capacity to keep the machine cool even during long, sustained operation.

Trade Literature

"Imperial" oxyacetylene welding and cutting equipment are described and prices listed in catalog No. 561, recently issued by The Imperial Brass Manufacturing Co., 522 S. Racine Ave., Chicago, Ill. Among the equipment listed are complete outfits for welding, cutting, lead burning, soldering and brazing, as well as welding and cutting torches, copper tips, gas regulators, gas blow torches, gas hose, goggles, cylinder trucks, welding rods and welding flux.

A new price list covering Maurath stainless and heat-resisting arc-welding electrodes has been issued by Maurath, Inc., 7309 Union Ave., Cleveland, Ohio. The procedure for welding is also given. The paper on which the list is printed is coated on one side to resemble a white metal, and makes an attractive folder.

"'Metalix' X-Ray for Industry" is the title of a booklet recently issued by the Industrial X-Ray Corp., Chamber of Commerce Bldg., Los Angeles, Calif. X-ray technique is described and illustrations show various applications to weld inspection.

Electric-hydraulic power devices, hydraulic cylinders, hydraulic control valves, and special equipment for both air and hydraulic operation, are described in a new 52-page catalog issued by The Logansport Machine Co., Logansport, Ind.

Possibilities in the design and construction of wheels by means of arc welding are given in detail in Application Sheet No. 35, Series 2, copies of which can be obtained from The Lincoln Electric Co., Dept. 235, Cleveland, Ohio.

The "Koch" goggle head-band and adjusting pins, designed for long life and ease of adjustment, are described in a leaflet issued by Koch's Welding Shop, 2843 Whittier Blvd., Los Angeles, Calif.

Commercial News

C. M. Rusk Heads Welding Division of Eastern Firm

Charles M. Rusk, welding engineer, heads the new division of the sales department of the Horace T. Potts Co., East Erie Ave. and D St., Philadelphia, Pa., established for the sale of welding rods, accessories and apparatus. Mr. Rusk will not only devote his time to sales work but will also render engineering assistance in welding problems of all kinds. The Potts company are district distributors for Page Steel & Wire Co., Manganese Steel Forge Co., Weatherly Foundry & Mfg. Co., American Brass Co., Simplex Wire & Cable Co., Chruchward Engineering Co., and Sellstrom Mfg. Co.

C. W. Steele Becomes "Rego" Sales Manager

Charles W. Steele, formerly president of the American Compressed Gas Co., has been appointed sales manager of the "Rego" Welding and Cutting Division of The Bastian-Blessing Co., according to E. L. Mills, vice-president. Mr. Steele's wide acquaintance in the industry has been gained through continuous activities, dating from 1918. His many contacts in various branches of the industry

CHARLES W. STEELE

throughout the United States afford him thorough familiarity with localized and individual needs. He is widely known throughout the trade for his many activities in behalf of the welding and cutting industry.

M. H. Kauer has been appointed sales promotion and advertising manager of The Bastian-Blessing Co.

It is stated that several new and interesting announcements covering recent additions to and developments in the "Rego" lines are slated for early release.

Takes to Wings in Promoting Welding

In his engineering consulting capacity with the Harnischfeger Corp., of Milwaukee, Klaus L. Hansen flies from city to city and plant to plant in maintaining his schedule of welding promotion. In

Airplane Used by K. L. Hansen

addition to a broader application of the electric arc made possible through recent perfections in the P&H-Hansen arc-welding generator, Mr. Hansen is doing considerable plant educational work on his arc torch which is designed for brazing non-ferrous metals and can be operated from a standard welding generator.

The Morton Manufacturing Co., Muskegon Heights, Mich., have appointed R. Lewis Giebel, 1501 Undercliff Ave., Bronx, New York City, as their representative in the New York metropolitan area.

Welding of Everdur metal by the carbon and metallic arcs and the oxyacetylene welding of iron with Tobin Bronze rod will feature The American Brass Co. exhibit at the National Metal Exposition, in Detroit, beginning October 2nd. Cast-iron parts repaired with Tobin Bronze rod and automatically welded Everdur tanks will be on display. C. E. Swift will be in charge of the demonstrations.

Hobart "Simplified" arc welders of motor-driven and gasoline-driven types will be shown in operation by the Hobart Brothers Co., Troy, Ohio, at the National Metal Exposition, to be held in Detroit starting October 2nd. Robert Bereaw, Hobart factory instructor, will demonstrate the new Long-Arc process of copper welding, which is applicable to either deoxidized or electrolytic copper.

The Sight Feed Generator Co., West Alexandria, Ohio, are aggressively opening new territories and establishing new accounts and new distributors. One distributor recently sold 10 "Sight Feed" acetylene generators in a single month.

Actual demonstrations of welding with Premier Tested welding wire and USS 18-8 stainless-coated welding wire will feature the display of the American Steel & Wire Co. at the National Metal Exposition, in Detroit, beginning October 2nd.

The Los Angeles office of the Lincoln Electric Co. reports the recent sale contract of 10,000 lb. of "Fleetweld" welding rod to the city of Los Angeles, to be used in welding a large water line in Bouquet Canyon, some 50 miles north of Los Angeles.

H. E. Menefee, formerly of the Terre Haute Heavy Hardware Co., Terre Haute, Ind., is now with the W. J. Holliday Co., of Indianapolis, Ind., in charge of the sales of welding equipment and supplies.

The Allsteel Press Co., 12015 Peoria St., Chicago, Ill., has appointed E. H. Merrick, Cook Building, Cleveland, Ohio, as exclusive representative in the Cleveland district.

News From the Field

Busy Shop Gets 8 Jobs in 15 Minutes

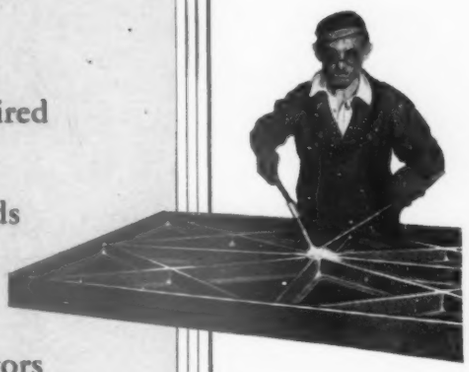
One of the busiest little shops ever visited by a *Welding Engineer* field man is one in Waupon, Wis., known as the Waupon General Repair Shop and owned by Herman Erdman.

Mr. Erdman employs one woodworker, two blacksmiths, and two welders, and in addition he himself does more than his share of work in the shop and also handles the customers. If it's a new wagon tongue, the wood shop can turn it out; and if it's metal, either the blacksmithing or welding department gets it. The welding equipment consists of one a.c. welding unit and two oxyacetylene outfits.

When the visitor from *The Welding Engineer* arrived, the shop had considerable work on hand, and in the 15 minutes he was there several pieces of work came in, including a silo-filler pipe in which a new section was to be welded in to replace a worn section, also three

8 reasons *why* thousands of welders believe Tobin Bronze *is* better!

1 Its low melting point
2 Its free-flowing qualities
3 Pre-heating seldom required
4 Minimizes distortion
5 Makes dense, tough welds
6 Uniform in composition
7 *Made by Anaconda*
8 Sold by leading distributors



There is a suitable Anaconda Filler Rod for every bronze-welding purpose. Principal Anaconda Welding Rods, with their melting points, are listed below:

for oxy-acetylene welding	
Tobin Bronze*	1625° F
Manganese Bronze	1598° F
Brazing Metal	1634° F
Electrolytic Copper	1981° F
Silicon Copper	1981° F
Phosphor Bronze	1922° F
Everdur*	1866° F
for arc welding	
Silicon Copper	1981° F
Phosphor Bronze	1922° F
Everdur*	1866° F

*Reg. U. S. Pat. Off.

"TOBIN BRONZE *must* be better... my men swear by it." This significant statement has been made by many welding foremen about Tobin Bronze... the original low melting point bronze rod. The consistently high quality which has always characterized this rod explains its popularity with thousands of satisfied users who will accept no other brand.

One of a line of seven Anaconda Copper Alloy Rods, Tobin Bronze is the most widely used... because of its widespread acceptance as the *ideal rod* for the general oxy-acetylene welding of cast iron and malleable iron. It melts at 1625° F.; preheating is usually unnecessary.

The uniform composition and unvarying quality of *all* Anaconda Welding Rods are due to the long experience and technical knowledge gained in developing a complete line for low temperature welding, both gas and electric. Available through leading distributors... usually shipped in bulk, but also obtainable in clearly labeled ten-pound packages. For information, ask for Publication B-13.

ANACONDA
from mine to consumer

THE AMERICAN BRASS COMPANY
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ANACONDA WELDING RODS

bicycles, three ensilage cutter knives to have the cutting edge hard-faced, and a plow which had a chunk broken out of the share point.

Mr. Erdman has sold himself, his business, and particularly welding to his community, and holds their confidence. It shows that a community sold on welding will respond.

This Job Shop Thrives on Plow-Share Business

A good, lucrative business in building-up and repointing worn cast-iron plow shares has been worked up by the Magley & Son Machine Shop at Columbia City, Ind. In the six working days from August 1st to 7th (Sunday excepted), 57 plow shares were brought into this concern's shop to be rebuilt. That farmers will have this work done is contrary to most reports from job welders. Maybe the secret lies in Mr. Magley's salesmanship and the fact that he goes hard after this kind of business.

Without waiting for a welding-shop code, the Madison Welding & Supply Co., 9 N. Ingersoll St., Madison, Wis., have stepped out and signed the President's Reemployment Agreement (the blanket code) and are now operating under the NRA. A. T. Harrington, proprietor, has not only adopted the code in spirit but is actually working under the conditions set up. He has painted the sign of the NRA, eagle and all, on the side of his shop for all to see, and the Madison newspapers have spoken very complimentarily of his aggressiveness in stepping to the front.

Bob Draver, of the Draver Electric Co., Richmond, Ind., recently built and sold to the Ben Ramels Garage, Fort Recovery, Ohio, a 150-ampere d.c. arc welder driven by a gasoline engine.

Chas. O. Smith, formerly a welder with the Morton Salt Co., of Ludington, Mich., has opened his own job welding shop at the north end of the State Road bridge in Ludington.

· CLASSIFIED ADS ·

Help Wanted—75c per line, minimum 4 lines. Jobs Wanted—4 lines free. Other Ads—$1.00 per line, minimum 4 lines. Count 8 words to line. Add 6 words for keyed address.

WANTED TO BUY

Wanted to Buy—Spot Welding Machine suitable for welding 20-gauge to ⅛-in. thick steel. Must be A-1 condition. State make, condition and price. Address Box 117, The Welding Engineer.

FOR SALE

For Sale—300-lb. D. B. Acetylene Generator. Like new. Price $250.00 f.o.b. Philadelphia, Pa. Medicinal Oxygen Co., 1718 Vine Street, Philadelphia, Pa.

Standardized Cutting and Welding Tips, interchangeable with various types of torches; also apparatus, accessories and complete outfits. Priced right. High quality and workmanship. Write for catalog. The Alexander Milburn Company selling on behalf of TIPS, INC., 1416-18 W. Baltimore St., Baltimore, Maryland.

For Sale—Welding and Machine Shop, established 1920. $10,000 worth of equipment in first-class shape will go for 50 per cent or less. We own our location and are in a position to give an immediate buyer free rent for six months or more. Must be a cash sale. Leo F. Amort, 217 West Montecito St., Santa Barbara, Calif.

FOR SALE

Bargains—Demonstrator Arc Welders. Gasoline, electric drive, belted, or coupled-together outfits. 30 days' trial. Easy terms, if desired. Write Ken's Welding Exchange, Box U-931, Troy, Ohio.

For Sale—Arc Welders, gasoline or electric driven. Spot Welders. Overhauled. Guaranteed. Attractively priced. Dealer correspondence invited. Electric Power Motors, Inc., 1087 East 97th St., Cleveland, Ohio.

POSITIONS WANTED

Welder—9 years' experience building coal shutes, elevators and other equipment, and repairing boilers. Can handle most any kind of welding job. Address Box 116, The Welding Engineer.

A-1 Maintenance Man who is a welder, auto mechanic, machinist, repairman, rebuilder, etc., wants responsible job with factory, mill, plant, etc. Can furnish own gas and electric-arc welding equipment. Intelligent American-German, sober, married, age 30. Highest references mailed on request. Will go anywhere if the job is permanent. Wm. Oesterle, Jr., Milmay, N. J.

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